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THE VIRGINIA JOURNAL OF SCIENCE

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VIRGINIA ACADEMY OF SCIENCE

PROCEEDINGS FOR THE YEAR
1959-1960

. 11, New Series September, 1960 No. 4

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THE VIRGINIA JOURNAL OF SCIENCE

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THE VIRGINIA JOURNAL OF SCIENCE

VOL. 11, NEW SERIES No. 4

VIRGINIA ACADEMY OF SCIENCE

Proceedings for the Year 1959 – 1960

MINUTES OF THE THIRTY-SEVENTH ANNUAL MEETING

MAY 6, 7, 8, 9, 1959

JEFFERSON HOTEL

RICHMOND, VIRGINIA

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1962

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1963

Dr. Boyd Harshbarger, (Chairman), Virginia Polytechnic Institute; Dr. Jesse Thompson, Hollins College; Dr. Harry Holloway, Roanoke College.

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Biology: Dr. Ivey F. Lewis, University of Virginia.

Engineering: Dr. R. M. Hubbard, 311 Montebello Circle, Charlottesville, Virginia.

Geology: Dr. B. N. Cooper, Virginia Polytechnic Institute.

Medical Sciences: Dr. Chalmers L. Gemmill, University of Virginia.

Psychology: Dr. Frank A. Geldard, University of Virginia.

Statistics: Dr. Boyd Harshbarger, Virginia Polytechnic Institute.

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General Chairman: Colonel S. M. Heflin, Virginia Military Institute.

Registration: Colonel R. C. Weaver, Virginia Military Institute.

Housing: Lt. Colonel Lewis R. Hundley, Virginia Military Institute.

Junior Academy: Colonel J. B. Newman, Virginia Military Institute.

Commercial Exhibits: Lt. Colonel D. R. Carpenter, Virginia Military Institute.

Meeting Rooms and Equipment: Colonel George M. Pickral, Virginia Military Institute.

Field Trips: Colonel R. P. Carroll, Virginia Military Institute.

Publicity: Mr. R. W. Jeffrey, Virginia Military Institute.

Signs and Maps: Lt. Colonel A. C. Taylor, Virginia Military Institute.

Traffic and Parking: Lt. Colonel S. M. Gillespie, Virginia Military Institute.

Special Dinners and Luncheons: Colonel Gene Wise, Virginia Military Institute.

Parades: Lt. Colonel S. M. Gillespie, Virginia Military Institute.

Entertainment for Ladies: Mrs. S. M. Heflin, Virginia Military Institute.

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THE VIRGINIA ACADEMY OF SCIENCE ASSEMBLY

BALL ROOM, JEFFERSON HOTEL, 8:00 P.M. MAY 13, 1960

The meeting was opened by President Hinton who introduced Colonel Herbert W. K. Fitzroy who welcomed the Academy on behalf of the University Center in Virginia. Colonel Fitzroy read the names of the Local Committee on Arrangements and complimented them on their work.

President Hinton then introduced Dr. Raymond L. Taylor, Associate Administrative Secretary of the AAAS who brought greetings from the Association.

President Hinton, acting for Mrs. Heatwole, announced the summer Teacher Sponsor Scholarships, one at the University of Virginia and the other at the College of William and Mary as:

Miss Virginia Ellett, Thomas Jefferson High School, and Mr. J. M. Lane, Victoria High School. Mr. J. P. Hill, Jr., of Stewartsville High School was named alternate to the former and Mrs. Martha Walsh, McLean High School, to the latter.

Dr. R. W. Engel announced the J. Shelton Horsley 31st Research Award selected from eleven competing papers was that of Mr. Lawrence I. Miller's entitled, "The Influence of Soil Components on the Survival and Development of the Sting Nematode." The Claude P. Talley, Lloyd E. Line, Jr. ,and Quinton D. Overman, Jr., paper entitled "Preparations and Properties of Massive Amorphous Elemental Boron" received Honorable Mention.

President Hinton announced that a set of bound volumes of the *Virginia Journal of Science* is to be presented to Dr. Mary E. Humphries in appreciation of her outstanding work on that Journal. Since she had not come to these meetings Dr. Horton Hobbs was asked to make the presentation later.

Miss Zoe Black read the resolutions formulated by the Resolution Committee which were approved.

Mr. Edward Harlow, Chairman of the Nominating Committee, presented the following slate:

President, Dr. Wilson Bell; President Elect, Dr. Horton H. Hobbs, Jr.; Secretary, Dr. Paul M. Patterson; Treasurer, Mr. Foley F. Smith; Assistant Secretary-Treasurer, Mr. William B. Wartman, Jr.; Council Member,

Miss Susie V. Floyd (5 years), Dr. Stanley B. Williams (4 years), Colonel H. W. K. Fitzroy (2 years).

Dr. Harshbarger moved that the Secretary be instructed to cast an affirmative ballot. The motion was seconded and passed.

President Hinton announced an invitation to the Academy to meet in Norfolk in 1962 had been received from The Norfolk Division of the College of William and Mary, together with the New Monticello Hotel, the Norfolk Chamber of Commerce and the Norfolk City Officials. He announced that this would be presented before Council in its morning meeting the next day.

Dr. Frank W. Finger then presented the speaker of the evening, Dr. Harry Harlow who spoke on the subject, "A Theory of the Development of Affection in Primates." After this interesting and informative illustrated lecture, Dr. Hinton thanked the Council officers, Committees and membership for their cooperation and turned the meeting over to President Bell who, after a few appropriate remarks, adjourned the Assembly.

COUNCIL MEETING

GLASGOW HOUSE, RICHMOND, VIRGINIA

10 A.M. MAY 14, 1960

President Bell called the meeting to order and welcomed the new members. Present wer: W. S. Flory, J. C. Forbs, Susie V. Floyd, T. E. Gilmer, W. G. Guy, W. M. Hinton, H. H Hobbs, G. W. Jeffers, P. M. Patterson, R. D. Ross, F. F. Smith, J. J. Taylor, W. B. Wartman, Jr., and S. B. Williams.

The minutes of the immediate past three meetings were reviewed to pick up unfinished business, then the agenda was completed for the meeting.

Dr. Guy presented the invitation for the Academy to meet in Norfolk in 1962. Dr. Gilmer moved the acceptance and it was seconded and passed.

Dr. Hinton moved that the registration fee for the Academy meetings be raised to $1.00 for senior members and visitors, leaving it at fifty cents for students. This motion was seconded and passed.

Dr. Jeffers moved that signs be placed at Section meetings stating "Admisison by Badge Only." This motion was seconded and passed. This was the outcome of a concern Council had over a number of per-

sons attending Section meetings without registering.

With regard to the Academy meeting place for 1963, Dr. Taylor moved that Council instruct President-elect, H. H. Hobbs to proceed on a meeting place for 1963 with the preference of the Hotel Roanoke for location.

A questionnaire from the AAAS Conference was then discussed. The four questions were answers as follows and the Secretary instructed to reply.

1. Should a strong National Junior Academy of Science be formed? No.
2. Should the local Junior Academy of Science remain under the sponsorship and jurisdiction of the local Senior Academy of Science? Yes.
3. If a strong national Junior Academy of Science is formed, should it be under the sponsorship or jurisdiction of the AAAS Academy Conference? No, under AAAS.
4. Would a new National Junior Academy of Science interfere with or harm any now existing National Youth Science group. Yes.

The proposals concerning the *Journal* as presented by Dr. Ross (reported on May 12 meeting) were discussed. Concerning advertisements Council advised that they be of a character appropriate to a scientific Journal. Dr. Ross advised that no fixed advertising price could be made as an advertising agency sold a package deal and defined the rate themselves. The increase of Academy support by $400 was approved by Council subject to the favorable action by the Finance Committee. A storage place for back numbers of the *Journal* was discussed but no solution found.

Dr. Jackson Taylor moved that a gavel be purchased and that the Awards Committee make a suitable presentation at the 1961 meeting.

Dr. Hobbs pointed out that the Biology Section formed a Committee to back up movements to preserve unspoiled natural areas in eastern Virginia. Council voiced the opinion that such maters should go through existing channels of the Academy or come before Council, and that Sections should not act unilaterally in the name of the Academy.

Adjournment.

P. M. Patterson, Secretary

COUNCIL MEETING OF MAY 12, 1960

President Hinton called the meeting to order at 2 p.m. in the Glasgow House, Richmond. Present were: W. B. Bell, L. A. DeArmon, J. C. Forbes, T. E. Gilmer, W. G. Guy, Boyd Harshbarger, Thelma C. Heatwole, G. W. Jeffers, S. S. Negus, B. A. Niemeier, P. M. Patterson, E. W. Pullen, R. D. Ross, M. B. Rowe, W. W. Scott, O. R. Singleton, Jr., F. F. Smith, J. J. Taylor, J. C. Thompson, Jr., W. B. Wartman, Jr.

The minutes of the March 12th Richmond meeting of Council were read and approved.

Dr. Forbes reported that NSF funds for 1959-60 Visiting Lecturers were not used entirely and over $1300 was returned. He reported that NSF funds were again available for visiting lecturers to the amount of $4890 and pointed out that NSF desired we enlarge the program by inviting high school science teachers and students to the general lecture given by the visiting scientists. With the reduced honorarium ($20 per diem) Dr. Forbes suggested the utilization of scientists in the state or geographically close by for this year's program. Dr. Jackson Taylor moved that the Visiting Scientists Program as outlined by Dr. Forbes be endorsed by Council. It was seconded and passed.

Mrs. Heatwole recommended that the chairman of the Junior Academy of Science Committee be made a member of Council.

Dr. Thompson recommended a reorganization of Council as follows: 1) that Council be composed of members elected by the several Sections, each Section designating one of their members as representing their Section on Council. 2) that the Nominating Committee for the officers of the Academy be the Council itself.

Mr. Harlow moved that the proposals made by Mrs. Heatwole and Dr. Thompson be studied by a Committee to be appointed by incomin President Bell. It was seconded and passed.

The Goethe Awards for travel expenses to the meeting were announced by Drs. Harshbarger and Hobbs as going to Charles Quesenbery of VPI and Harison R. Steeves of the University of Virginia.

Dr. Ross reported on the *Virginia Journal of Science* giving a financial statement and proposed budget for 1960-61. He then outlined in detail the duties of the Edtior and Manager and designated plans for the improvement of the *Journal* as follows: 1. The *Journal* should appear promptly each quarter; 2. Its articles should be more representative of the several science; 3. That the report of the Committee headed by Dr.

Bell to study the finances of the *Journal* be considered, and follows in part:

1. Increase pages of advertising from 6 to 12. 2. Increase in advertisement rates. 3. An additional subsidy from the Academy of $400. 4. That an Advertising Manager be appointed and that the services of an advertising agency be acquired. Dr. Hobbs moved that Council receive this report with thanks to the Committee for their work. This motion was seconded and passed.

President Hinton reported he had represented the Academy at the recent Presidential inagurations at the University of Virginia and Washington and Lee University.

Mr. Wartman presented a proposed form to be printed for the Academy's Certificate of Business Memberships and asked for suggestions as to its format.

Mr. Smith reported he had taken out liability insurance to cover the three days' meeting of the Academy.

MEETING OF THE ACADEMY CONFERENCE

HOTEL JEFFERSON, MAY 12, 1960 – 8:00 P.M.

President Hinton presided and called for the reports of Committees published elsewhere in this issue. With respect to obtaining the $400 additional subsidy requested for the *Journal* (see previous minutes) Dr. Forbes recommended that the registration fee of fifty cents be raised to $1.00. It was moved that Council consider this matter and the group would favor Council's decision. This motion was seconded and passed.

TABULATION OF REGISTRATION

The Junior Academy of Science registered 207 members. The registration according to Sections was: Agricultural Sciences, 21 members, 24 nonmembers, total 45; Astronomy, Mathematics and Physics 46 members, 31 nonmembers, total 77; Bacteriology 14 members, 8 nonmembers, total 22; Biological Sciences 60 members, 31 nonmembers, total 91; Chemistry 85 members, 46 nonmembers, total 131; Engineering 10 members, 13 nonmembers, total 23; Geology 13 members, 5 nonmembers, total 18; Medical Sciences 16 members, 8 nonmembers, total 24; Psychology 32 members, 20 nonmembers, total 52; Science Teachers 14 members, 8 nonmmbers, total 22; Statistics 13 members, 16 nonmembers, total 29. Three members and 37 nonmembers registered without preferenc to section. The total registration was 781.

VIRGINIA ACADEMY OF SCIENCE BUSINESS MEMBERS

At a recent Council Meeting it was decided to send Business Membership Certificates to all business members and that the Company names be listed in an appropriate place in the *Journal*. Curently there are seventeen business members.

BUSINESS MEMBERS, AUGUST 12, 1960

Allied Chemical Corporation, Nitrogen Division, Development Department, Hopewell, Virginia. The American Tobacco Company, Department of Research and Development, 400 Jefferson Davis Highway, Richmond 24, Virginia. E. I. DuPont de Nemours & Co., Inc., Textile Fibers Department, Richmond, Virginia. The Dow Chemical Company, Textile Fibers Department, Attn: Mr. O. R. McIntire, Technical Director, Williamsburg, Virginia. Esso Standard Oil Company, Attn: Mr. C. C. Pembroke, Broad & Hamilton Streets, Richmond, Virginia. First and Merchants National Bank, Attn: Mr. R. T. Marsh, Jr., President, Richmond 17, Virginia. General Electric Company, Employee & Community Relations, Attn: Mr. Paul R. Thomson, Manager, 1501 Roanoke Boulevard, Salem, Virginia. Larus & Brother Company, Inc., Attn: Mr. A. T. Webster, Secretary and Treasurer, Richmond 17, Virginia. Merck and Company, Inc., Research Laboratories, Attn: Dr. Max Tishler, Rahway, New Jersey. Philip Morris & Co., Ltd. Inc., McComas Research Center, Attn: Dr. Helmut Wakeham, Director of Research, P. O. Box 3D, Richmond 6, Virginia. The Newport News Shipbuilding & Drydock Company, Newport News, Virginia. Norfolk and Western Railway Company, Attn: Mr. Martin P. Burks, Roanoke 17, Virginia. Phipps and Bird, Inc., 303 South 6th Street, Richmond, Virginia. A. H. Robins Company, Inc., 1407 Cummings Drive, Richmond, Virginia. Reynolds Metals Company, Attn: Mr. R. S. Reynolds, Jr., Richmond, Virginia. State-Planters Bank of Commerce and Trusts, Attn: Mr. Charles E. Moore, Jr., Vice President, Richmond 14, Virginia. Virginia-Carolina Chemical Corp., Research Department Library, Box 1136, Richmond 8, Virginia.

GENERAL FUND
STATEMENT OF CASH RECEIPTS AND DISBURSEMENTS
FOR THE YEAR ENDED DECEMBER 31, 1959

BALANCE ON DEPOSIT—JANUARY 1, 1959		$ 5,432.60
RECEIPTS:		
Revenue:		
Dues:		
Regular members	$ 2,130.00	$ 4,294.00
Collegiate members	32.00	

Contributing members	663.00		
Sustaining members	380.00		
Business members	1,000.00		
Delinquent dues	89.00	$ 4,294.00	
Gifts, grants and bequests:			
Virginia Junior Academy of Science			750.00
General			200.00
Non-Revenue:			
Major W. Catesby Jones Award Fund			10.00
Advance Payment of Dues			18.00
Receipts from annual meeting, May, 1959:			
Collection of Advance due from Research Account		40.00	
Fees for exhibit space	$ 700.00		
Registration fees	291.00	991.00	
Miscellaneous collections		94.34	
Sale of James River Basin books		10.50	
Dividends on stock		119.15	
Income from special trust fund (Exhibit G)		96.06	
Award check (1955) cancelled		11.65	
Total Receipts for the Year			6,634.70
Total Funds Available			$12,067.30
DISBURSEMENTS:			
Annual Meeting Expense		$ 988.36	
American Association for the Advancement of Science Meeting		359.52	
Virginia Junior Academy of Science		2,164.83	
Postage and express		89.32	
Printing		69.76	
Science talent search		449.14	
Stationery, supplies and stenographic services		111.14	
Virginia Journal of Science		2,005.75	
Dr. E. C. L. Miller Award		50.00	
Major W. Catesby Jones Award		10.00	
Miscellaneous and General Expense (Schedule B-1)		371.59	
Cash transfer to Special Trust Fund Principal Account (Exhibit F)		3,000.00	
Total Disbursements for the Year			9,669.41
BALANCE ON DEPOSIT – DECEMBER 31, 1959 (Exhibit A)			$ 2,397.89

SECTION OF AGRICULTURE

PHOTOPERIODISM IN TURKEYS

A. T. Leighton, Jr.; *Virginia Polytechnic Institute*

1. This study was designed to obtain information on the photoperiodic response of female turkeys as measured by reproductive responses to various light regimes. Light, restricted to 6 hours per day for a 2 or 4 week period and subsequent exposure to 15 hours of light, made it possible to induce turkeys to lay at a significantly earlier age and at a higher rate during the fall than females which were previously maintained under 14 hours of natural daylight. Light alteration resulted in a change in time of response but had no apparent effect on total egg production over a 6 months production period. (Study conducted at the Minnesota Agricultural Experiment Station, St. Paul, Minnesota.)

SUSCEPTIBILITY OF THREE BREEDS OF CHICKENS TO BLACKHEAD

Everett E. Lund; *Animal Disease and Parasite Research Division, A.R.S., U.S.D.A.*

2. New Hampshire Reds, White Leghorns, and first generation crosses of New Hampshire Red males and Bared Rock females, all 5 weeks of age, were given equal numbers of embryonated *Heterakis* eggs from a source known to transmit blackhead. *Histomonas* infection appeared in 92, 75 and 66 percent of these birds, respectively, and 25, 21 and 6 percent, respectively, remained carriers after the acute state subsided. Worm loss was in direct proportion to the severity of the blackhead. Infectivity of eggs from worms recovered from the above birds varied according to the incidence of blackhead. All breeds were capable of significant soil contamination.

A MODIFIED EXTRACTION-TITRATION TEST FOR FREE FAT ACIDITY OF MILK AND CREAM

W. K. Stone and P. M. Large; *Virginia Polytechnic Institute*

3. Free fat acidity (FFA) was determined using equipment common to dairy quality control laboratories. Nine ml. of milk were shaken in a Babcock cream-test bottle for 1 minute with 10 ml. of neutralized 95% ethanol. This mixture was extracted by shaking for 1 minute with 15 ml. of 40/60 ethyl-petroleum ether and centrifuged for 3 minutes in a Babcock centrifuge. Five ml. were decanted, mixed with 5 ml. of neutralized ethanol; and titrated with ca. 0.01 N alcoholic KOH. FFA $=$ net ml. KOH $\times$ N $\times$ 300 $\div$ by weight of fat in the sample. To

test cream for FFA, an amount containing 0.40 g. of fat was weighed, diluted to 9 ml. with H_2O, and tested as above.

THE EFFECT OF DIETARY SODIUM BROMIDE LEVEL UPON THE RATS' GROWTH AND CARCASS AND LIVER BROMIDE LEVELS

Russell F. Miller and Janet M. Paulsen;
Virginia Polytechnic Institute

4. The addition of 0.25, 0.50, 0.75, or 1.00 g of NaBr/kg of purified diet for 6 weeks, did not adversely affect the growth of weanling albino rats. Based upon fresh weight, these rats' liver bromide levels increased (control 4 ppm) to 48 ppm (0.25 g NaBr/kg diet) then linearly to 79 ppm as the dietary NaBr level increased to 1.00 g/kg of diet. Carcass bromide levels, fresh basis, increased linearly from a control value of 15 ppm to 118 ppm when 0.75 g of NaBr/kg of diet was fed and did not increase further when feeding 1.00 g of NaBr/kg of diet.

THE BLOOD PICTURE IN WOOD SHEEP AND DAIRY GOATS

Lubow A. Margolena; *Sheep and Fur Animal Research Branch, A.R.S., U.S.D.A.*

5. The haematology of two groups each of Mernio and Hampshire sheep and Toggenburg goats was studied throughout the seasons of the year at Beltsville, Maryland. One group was on pasture, the other on a standard diet. Despite considerable individual differences, average values tend to be representative of a breed if considered on a long range basis. Hampshires averaged 13.7 gr. haemoglobin per 100 ml. blood, Merinos 13.2 and Toggenburg does 12.8 respectively. Yearly percent averages for red cell volume were 37.8 for Hampshires, 36.2 for Merinos, and 32.8 for the does. Sedimentation rates read on 24 hour perpendicularly steadied Wintrobe tubes were fractions of 1 in all healthy animals. A rate of 2 and over was found only in a buck dying of pneumonia.

GENETIC PARAMETERS CONCERNED WITH FEED EFFICIENCY FULL FED BEEF CATTLE

James A. Gaines; *Virginia Polytechnic Institute*

6. Data on 276 bulls individually fed at the Beef Cattle Research Station, Front Royal, and on 152 steers individually fed at the Virginia Agricultural Experiment Station at Blacksburg were available for this study. The least squares method of analysis was used. In the first phase the data were adjusted for years, breeds, initial weight, and total

gain prior to estimating heritabilities of .79 in the bulls and .09 in the steers for TDN/cwt. gain. In the second phase indivdiual total gains and TDN/cwt. values were adjusted for years, breeds, and initial weight prior to estimating genetic correlations of −1.31 in steers and −0.67 in bulls.

THE EFFECTS OF VARIOUS LEVELS OF LYSINE IN THE DIET ON MUSCLE DEVELOPMENT AND ON VARIOUS BLOOD PHENOMENA OF GROWING SWINE

G. M. Cahilly, R. F. Kelly, C. C. Brooks, J. W. Davis, and P. P. Graham; *Virginia Polytechnic Institute*

7. An experiment was conducted involving 24 pigs to determine the effects produced by feed-protein quality on various physiological phenomena in growing swine. A corn-peanut oil meal ration supplemented with graded levels of lysine was used. Preliminary results indicated that lysine supplementation to this ration increased muscle mass, the nature of this increase being in the form of protein, not water or fat. Figures also indicated that changes may occur in organ wegihts and in blood paterns as a result of feed-protein quality. Determination of blood fractions, muscle lysine, as well as rat-growth study are in progress.

THE EFFECTIVENESS OF THREE MANAGEMENT SYSTEMS FOR THE CONTROL OF INTERNAL PARASITES OF LAMBS

James H. Turner, K. C. Kates, I. Lindahl, G. E. Whitmore, and F. D. Enzie; *Agricultural Research Service, Beltsville, Md.*

8. From March to September of 1959, 3 bands of 20 lambs each were raised on dry lots, "clean" pastures, and parasite-contaminated pastures, respectivel,y and were kept under parasite surveillance. Each band was thus exposed to low, moderate, and high levels of parasitism, respectively. All lambs were on phenothiazine-salt prophylaxis. The principal parasites observed in the pastured lambs were *Haemonchus contortus* and *Strongyloides papillosus*, which caused anemia and inhibited growth. In the dry-lot group, significant parasitism did not develop, and therapeutic medication was unnecessary. The lambs exposed to high levels of parasitism required additional medication in June, whereas those exposed to moderate parasitism did not require therapeutic medication until late summer.

PESTICIDE RESIDUES

James F. Eheart, P. H. Massey, Jr., E. C. Turner and Jean Dickinson; *Virginia Polytechnic Institute*

9. Persistence curves, with recovery data, were made on 4 different

residues on collards, green beans, alfalfa and milk. Studies of the adaptation of the sodium biphenyl reduction method for organic chloride residues (endrin) with colorimetric determination of the resulting chloride ions by the ferric perchlorate-mercuric thiocyanate method was attempted.

CALCIUM SOURCES FOR PEANUTS

D. L. Hallock; *Virginia Agricultural Experiment Station*

10. Plenty of available calcium is required in the fruiting zone of peanuts. Four substances were evaluated as calcium sources for peanuts during the period 1956 to 1959. Rates of application were such to give 150 pounds per acre of calcium. The average acre value of the peanuts was $0.56, 3.00 and 3.75 greater from gypsum (landplaster) than from North American Cement Company potash lime, burnt shell lime, and finely ground limestone, respectively. For the peanut farmers of Virginia this would mean a difference of from $59,000 to as much as $400,000, anually, exclusive of the differential in cost of the various materials.

THE INFLUENCE OF SOIL COMPONENTS ON THE SURVIVAL AND DEVELOPMENT OF THE STING NEMATODE, *Belonolaimus longicaudatus* RAU

Lawrence I. Miller; *Virginia Agricultural Experiment Station*

11. Experiments conducted in the laboratory and greenhouse showed that osmotic concentration, temperature, and the pH of a liquid medium; the number of roots in a soil; the addition of organic matter and of sulphur to a soil; and the moisture level and the texture of a soil affects survival and development of the sting nematode, *Belonolaimus longicaudatus* Rau. Results of experiments conducted in the field in Virginia for the last 10 years showed, however, that soil texture was the principal limiting factor. It is concluded that this sting nematode is limited to soils of a certain texture.

TWO RECENT DEVELOPMENTS OF GREAT SIGNIFICANCE IN CORN GROWING

W. W. Moschler; *Virginia Polytechnic Institute*

12. Corn growing in Virginia in the future will be influenced by 2 new practices, "minimum tillage" and "soil profile modification." "Minimum tillage" is the growing of corn with the least amount of soil tillage necessary. The amount necessary is less than that presently employed and can be concentrated on the corn rows at the time of planting, leaving the soil between the rows in a relatively rough state. "Soil profile modification" involves the mechanical incorporation of lime and fertilizer

to greater than normal depths in the soil, thus increasing the effective depth of the rooting zone. In limited trials in nearby states, this practice has increased resistance to drought.

DETECTION OF SEED TREATMENTS

W. F. Crosier* and C. F. Bruce; *Virginia Department of Agriculture*

13. Different fungi were studied and the following, listed in order of sensitivity, were found to be satisfactory for bio-assay: *Glomerella cingulata, Curvularia inaequalis, Aspergillus niger, Stemphylium consortiale,* and *Myrothecium verrucaria.* Pure cultures of these fungi are grown in tube slants (70°C or room temperature) on an agar medium (sabouraud dextrose agar). After the surfaces are covered with spores the tubes are stored at 5°C until needed. Ten ml. of sterile water is poured into tube slant and agitated. The suspension of spores is poured into 250 ml. of liquid agar (40 to 45°C). Before it solidifies the spore-laden agar is poured into sterile Petri dishes. The seeds to be assayed are placed on the spored agar immediately after it hardens. From 10 to 15 seeds of small grains or approximately 1/in.2 can be placed in a 90 mm. Petri dish. Dishes are held at room temperature, to permit germination of spores, for 2 to 3 days before measuring the inhibition zones or halos around the seed, produced by the presence of a fungicide. Distribution and intensity of treatment can be judged by size and consistency of the halos. This method clearly indicates the presence of a fungicide, but identification of the materials is not revealed by this assay. (*Seed Pathologist, New York State Agricultural Experiment Station, Geneva, New York.)

THE SOYBEAN CYST NEMATODE; A NEW VIRGINIA PEST

W. H. Matheny; *Virginia Department of Agriculture*

14. The Soybean Cyst Nematode, *Heterodera glycines* Ichinohe, known to occur in Japan since 1915, was discovered, for the first time in the United States, in North Carolina in 1954. A detection survey was inaugurated in 1955 by the Virginia Department of Agriculture Division of Plant Industry. In 1958, two farms in lower Nansemond County were found infested. A delimiting survey showed there were 3000 acres infested on 53 farms and as of May 1960 there were 125 infested farms. A Federal and State Quarantine was made effective on September 1, 1959. Compressed air machines were assigned to the 2 areas to clean farm machinery and crops were harvested and handled by approved methods to prevent spread. Crop rotations will control the pest and several chemicals although quite expensive will give control. Two soybean varieties, Illsoy and Peking, are reported to be resistant. The cur-

rent program objectives are to contain the pest, discourage the planting of host crops and keep trade channels open through certification.

AMMONIUM IN CERTAIN VIRGINIA SOILS

C. I. Rich; *Virginia Polytechnic Institute*

15. Significant quantities of ammonium occur naturally in certain Virginia soils and may be an important source of nitrogen for plants. As much as 800 pounds of N per acre as NH4 may occur in the upper 5 feet of some virgin soils. This ammonium occurs as exchangeable ions or held in a "fixed" form by inorganic cation exchangers in soils. Vermiculite and weathered micas appear to be the major minerals retaining this ammonium. The proportion of the NH4 which is fixed varies with the amount of vermiculite and its ability to contract when NH4 or K saturated.

EFFECTIVENESS OF PHOSFON AS A CHEMICAL HEIGHT-RETARDANT ON POTTED CHRYSANTHEMUMS AND EASTER LILIES

Charles R. Downing and Staley L. Felton;
Virginia-Carolina Chemical Corporation

16. Phosfon, tributyl-2, 4-dichlorobenzylphosphonium chloride, retarded the height of chrysanthemums and Easter lilies when applied as a soil amendment. Rates of 0.25 to 0.5 gms. actual Phosfon per cu. ft. of potting soil reduced height about 50 percent. Treated plants were compact, had shorter internodes, stronger stems, leaves were very dark green, and blooms were not reduced in size or quality when treated at recommended rates. Flowering of treated plants was delayed slightly. All varities of chrysanthemums responded, but some were more sensitive than others. Rates of application were adjusted to compensate for sensitivity. Phosfon effectively retarded the height of potted Easter lilies (Ace, Croft, and Georgia). Treated plants were compact, had shortened internodes, and the size and quality of blooms were not reduced. Phosfon appeared to be of commercial value to producers of potted chrysanthmums and Easter lilies.

THE IDENTIFICATION OF PAINT OILS VIA GAS-LIQUID CHROMATOGRAPHY

W. L. Zielinski, Jr., W. V. Moseley, Jr., and R. C. Bricker; Paint Laboratory; *Virginia Department of Agriculture*

17. Oil analysis by Gas-Liquid Chromatography offers a unique method for elucidating the changes undergone by oils in the varied manufacturing processes of the paint industry. Oils were extracted from paint vehicles and introduced into a Perkin-Elmer 154-C Vapor Fractometer

as fatty acid methyl esters. Correlation was made between fatty acid distributions obtained and known fatty acid distributions of vegetable and fish oils. Some effects noted in the manufacture of oil-containing resins included the disappearance of eleostearic acid of tung oil through polymerization; the increase in drying power of soybean oil as a result of linoleic acid conjugation; and the resolution of complex oil mixtures. Identifiaction of unaltered oils is reported as routine.

WHAT CAN AN AGRICULTURAL ECONOMIST CONTRIBUTE TO RESEARCH IN THE NATURAL SCIENCES?

Ross V. Baumann, Farm Economics Research Division, *Agricultural Research Service, Washington, D. C.*

18. Natural scientists and economists have been quite successful in cooperative research. However, only about 10 percent of the projects reported in the natural science research journals have reached the stage that would permit economic application directly to farming. Some experiments could be designed to meet this need, but in some cases additional experimentation would be necessary. The experiment must provide alternatives to select from, or show the production relationship over the relevant economic area. This enables the economist to compare returns from the alternatives with returns obtained from practices already a part of the farm business.

THE ROLE OF PRICE EXPECTATIONS IN AGRICULTURAL SUPPLY RELATIONSHIPS

Olman Hee; *Statistical and Historical Research, Agricultural Marketing Service*

19. In economics we are frequently engaged in studies dealing with the law of supply. As the price of a product is increased, larger quantities of that product will be produced and offered for sale. The present study of supply-price reltionships postulates that farm operators' actions are largely consistent with price movements, after allowing for technological, institutional and cultural changes. This essentially describes a supply function. The basic formulation in this statistical analysis expresses acreage of potatoes as a function of expected price and other factors. The formulation also assumes that farmers continually revise their price expectations in relation to prices they actually received in the past and those which they had expected to receive. Results from statistical analysis indicad an elasticity of supply with respect to expected price of about 0.5, while the elasticity with respect to price in the previous year was approximatly 0.1.

PEANUT SUPPLY FUNCTIONS AND THEIR IMPLICATIONS FOR POLICY

D. Upon Livrmore; *Virginia Polytechnic Institute*

20. The purpose of this study was to estimate the national production of peanuts from 1959 to 1965. Acreage allotments have been reduced to the minimum of 1,610,000 acres permitted by Congress. Yields per acre have been increasing. Production has exceeded national requirements in most years. Production estimates will be compared with expected requirements to determine the extent to which surpluses may be expected. Methodology includes use of state acreage, yield, and production models for the period 1909-1958; relationships among factors are analyzed by means of single linear equations determined by ordinary least squares. Projections of production are based primarily on projected yields and curent levels of price support and acreage allotments.

USING TIME AND COST TECHNIQUES TO REDUCE COST IN VIRGINIA'S EGG MARKETING FIRMS

E. C. Garland, Jr.; *Virginia Department of Agriculture*

21. The introduction of automation in Virginia egg marketing firms presents new problems for management. The main problem appears to be: can the cost of automation be justified? Within the last three years, 22 time and cost surveys have been made to detect inefficiencies and excessive costs in Virginia egg marketing firms. These surveys revealed that it is not justifiable to candle poor quality eggs over automatic egg grading equipment. Usually hand candlers are used to grade poor quality eggs, resulting in a higher candling cost because of management's inability to attain maximium labor efficiency in a dual candling process. A preliminary study was made to compare the cost of grading eggs on automatic machines, using reasonably well-trained personnel, and by the conventional hand grading method. The study indicated when the problems of labor and volume were solved, that eggs could be candled and packed one-half cent per dozen cheaper by automatic machines. The study also revealed that the fully automatic machines were practically one-half cent cheaper that the semi-automatic.

INFLUENCE OF TECHNOLOGICAL DEBELOPMENT ON THE HANDLING OF VIRGINIA GRADE-A MILK

R. F. Hutcheson; *Virginia Department of Agriculture*

22. Since the 1930's, there has been a tremendous development of machinery and equipment to handle and process milk. Improved equipment and better methods have changed the milk production, processing, and marketing problems from a local situation to one that covers the entire

state of Virginia and extends several hundred miles beyond. Nearly 90 per cent of Virginia's grade-A milk is cooled and stored in bulk tanks, and 25 per cent of it is handled by pipe-line milkers. Raw milk is moved daily over 400 miles in bulk tanks. Most of the grade-A milk is standardized for butterfat content and flavor, and is homogenized before bottling. Improved pasteurization, improved refrigeration, and improved transportation is rapidly changing the milk market pattern to where it is paralleling eggs, fresh vegetables, fish, and meats as a product normally purchased along with canned goods and the rest of the groceries on the housewife's list.

SECTION OF ASTRONOMY, MATHEMATICS AND PHYSICS

AN ULTRA-HIGH VACUUM SYSTEM FOR THE DEPOSITION OF THIN METALLIC FILMS

Calvin O. Tiller; *Virginia Institute for Scientific Research*

1. An ultra-high vacuum system has been constructed that will allow a thin metallic film to be deposited by evaporation at pressures less than 10-8 mm of Hg. The Alpert techniques for obtaining pressures in the 10-10 mm of Hg range have been followed.

STRUCTURES OF AG FILMS DEPOSITED ON A SINGLE CRYSTAL OF NACI (work done at the Virginia Institute for Scientific Research)

Billy W. Sloope; *University of Richmond*

2. The conditions of formation of good single crystal films of Ag deposited on freshly cleaved NaCl surfaces are discussed in terms of preheat annealing of the substrate, post-heat annealing of the films and deposition temperture. Structures of these films were determined by transmission electron diffraction and glancing angle X-ray techniques. The effects of heat treatment on the agglomeration of the film and their structure are shown.

AN APPARATUS FOR MEASURING THE ANGULAR DISTRIBUTION OF THE TWO-GAMMA ANNIHILATION OF POSITRONS

William C. Doughty; *Hampden-Sydney College*

3. The angular distribution of the two-gamma annihilation of positrons in matter is thought to depend on the density and the identity of the matter; moreover, a knowledge of this angular distribution for a given sample can be used as a source of information about the interior of the

sample. The instrument described has as its essential components two scintillation type gamma-ray detectors and a mechanical device for changing the relative positions of the detectors.

POSITRON ANNIHILATION IN SODIUM, MAGNESIUM, AND ALUMINUM

Roger S. Cortesi; *University of Virginia*

4. Two photon angular correlation data from the annihilation of positrons in sodium, magnesium ,and aluminum are given. The Parabolic portion of the curves is fitted to a parabola, and from this the momentum at the surface of the Fermi sphere is measured, and the percentage of positron annihilating with conduction electrons is estimated. The results are given below with the Fermi surface results compared to a simple electron density calcuation.

Momentum at the Fermi surface in units of mc x 10-3

	Na	Mg	Al
Exp	3.6	5.4	6.8
Theory	3.5	5.2	6.7

Percentage of positron annihilating with conduction electrons

Na	Mg	Al
68	79	85

A LOW TEMPERATURE COOLING STAGE

James Wilkins and T. E. Leinhardt; *Virginia Polytechnic Institute*

5. A device for performing low temperature optical experiments is mounted in a Dewer flask containing liquid nitrogen. Liquid and vapor from the flask is directed through a vacuum jacketed stainless steel tube to the base of a copper stage. The vapor part of the stage to which specimens can be mounted is in an evacuated region. After flowing from the base of this stage the cooling vapors are directed thrcugh a series of concentric stainless steel tubes surounding the copper stage. The vapors are exhausted through a small value. For fast cooling a pump may be used. In tests temperatures between 300° K. and 80° K. were maintained with good stability.

FAR-INFRARED SPECTROMETER FOR WORK AT LOW TEMPERATURES

Robert J. Bell and T. E. Leinhardt; *Virginia Polytechnic Institute*

6. An Ebert-Fastie type spectrometer for low temperature research in the wavelength region 300 to 2500 microns is described for expcted

resolution $R = \frac{\lambda}{d\lambda} = 10^4$. The system can be used for solid, liquid, and gas phase sample studies over wide temperature ranges. By symmetry arangements spherical aberration and astigmatism are greatly reduced. Ground plate reflection filters are employed to eliminate higher order wavelengths, and a sensitive thermopile of expected sensitivity of 10^{-12} watts is considered as a detector.

$\overline{cm^2}$

URANIUM UPTAKE IN NUCLEAR EMULSIONS

Richard E. Garrett; *Hollins College*

7. The number of uranium atoms per unit volume of several types of nuclear emulsions loaded at different pH values is determined by counting the alpha tracks in the emulsion due to the decay of the uranium. The type C emulsion shows a constant uptake for pH values from 4.5 to 7.5 while the L type emulsion show marked dependence on pH for a given uptake.

THE MEASUREMENT OF THE ELECTRON AND OTHER SMALL CHARGES BY THE MAGNETIC BALANCE METHOD

J. W. Beams; *University of Virginia*

8. The magnetic balance method will measure masses to the order of one part in 10^9 even for extremely small ferromagnetic masses. The electrical charges on a small magnetically suspended particle in a vacuum may be determined by applying an electrical field and determining the resulting force on the particle by the magnetic support. The precision obtained for the charge on the electron should be greater than that obtaind by the classical Milliken oil drop method. The possibility of testing the Lyttleton and Bondi hypothesis that the charges on the proton differs by a small amount from that of the electron is discussed. (Supported by Bur. Ord. U. S. Navy).

TRANSVERSAL DOPPLER SHIFT USING THE MOSSBAUER EFFECT

J. W. Beams and S. Berko; *University of Virginia*

9. The progress of an experiment designed to test the second order Doppler shift to a high degree of accuracy is described. The experiment consists of measuring the resonance absorption of the 14.4 Kev gamma line from Fe^{57}, deposited at the center of an air driven specially designed ultracentrifuge, in an iron foil supported at the periphery of the centrifuge. The centrifuge is designed to obtain peripheral speeds

of 4 x 10^4 cm/sec. The results of the calibration of the system to obtain the shape of the Mossbauer line will also be presented.

MOLECULAR WEIGHTS

R. D. Boyle and P. E. Hexner; *University of Virginia*

10. A method is described for measuring molecular weights of organic compounds including insulin by the equilibrium ultracentrifuge method. A magnetically suspended rotor is operated in a vacuum system at constant temperature and speed for extended periods of time. The system measures molecular weights to a degree of accuracy of 1 part in 10^3. (Supported by the National Science Foundation)

PRODUCTION OF HIGH VACUA WITH A MAGNETICALLY SUPPORTED CENTRIFUGE

C. E. Williams; *University of Virginia*

11. A magnetically supported rotor is scaleed in a chamber free of lubricants and the pressure is lowered until the mean free path is large compared to geometrical distances inside the chamber. Molecular pumping as a function of pripheral velocity is discussed. (Supported by Office of Ordnance Research of the Army and Navy Bureau of Ordnance.)

PHOTONEUTRON CROSS SECTIONS FOR COBALT AND MANGANESE

P. A. Flournoy, R. S. Tickle, and W. D. Whitehead; *University of Virginia*

12. The total photoneutron yields for Mn^{55} and Co^{59} were carefully measured from threshold to approximately 30 Mev. Analysis of these data using the Leiss-Penfold matrix indicates that the cross sections for both elements show a splitting in the giant resonance region in accord with the predictions of the classical hydrodynamic model. The Mn^{55} peaks occur at energies of 16.8 $\pm$ .25 Mev and 19.75 $\pm$ .25 Mev corresponding to cross sections of 90 mb and 77 mb respectively. $Co.^{59}$ maxima occur at 16.5 $\pm$ .25 Mev and 19.0 $\pm$ .25 Mev with cross sections of 109 mb and 92 mb. The cross sections $\sigma(\gamma, n) + \sigma(\gamma, 2n) + \sigma(\gamma, np) + \ldots$ integrated to 25 Mev are 627 Mev-mb for Mn^{55} and 709 Mev-mb for Co^{59}. Breit-Wigner resonance lines were fitted to both cross sections and the intrinsic quadrupole moments determined from these fits are + .78 $\pm$ .11 barns for cobalt. (Supported by the Air Force Office of Scientific Research).

SOME USES OF PULSED NEUTRONS IN REACTOR PHYSICS

L. S. Anthony, J. L. McClure, and Andrew Robeson;
Virginia Polytechnic Institute

13. In recent years, steady state measurements with neutron sources have been superseded by modulated or pulsed neutron sources. Descriptions of some of the applications of pulsed neutron technique to nuclear and reactor physics are given, with emphasis on the types of experiments planned for the V. P. I. 250 kilovolt Cockcroft-Walton accelerator.

AN ACCELERATOR FOR PRODUCING NEUTRON PULSES

J. L. McClure, L. S. Anthony, and Andrew Robeson;
Virginia Polytechnic Institute

14. A Cockcroft-alton accelerator to produce neutron pulses of moderately high intensities has been built at Virginia Polytechnic Institute. The high voltage supply, a continuously variable voltage doubler circuit, will deliver a maximum of 2 ma. at 250 KV. Neutrons are produced using the D(d, n) He^3 reaction and pulses obtained by sweeping the deuteron beam from r.f. ion source across an exit port with electrostatic deflection plates. The entire system is mounted on casters to provide a reasonable degree of flexibility. A single channel variable-gate timing circuit, triggered by a pulse from the target, is used to measure time dependent neutron intensities in moderator materials. A fast twenty channel system is under construction. Experiments are underway to verify time dependent nutron distributions predicted by Monte Carlo computations on an IBM 650 computer. (A. E. C. Fellow in Nuclear Science and Engineering).

A MONTE CARLO ANALYSIS OF NEUTRON THERMALIZATION IN GRAPHITE

P. A. Newman and W. B. Payne; *Virginia Polytechnic Institute*

15. In conjunction with the pulsed neutron project at V.P.I., a Monte Carlo model has been prepared to give energy and spacial neutron distributions in a block of reactor grade graphite. Slowing down time and Fermi age are determined and the energy — time neutron distributions agree well with those of Marshak. The IBM 650 computer in the V.P.I. Computation Laboratory was used for this analysis.

THE DESIGN AND CONSTRUCTION OF A SINGLE CHANNEL TIME ANALYZER

W. D. Beasley and W. B. Payne; *Virginia Polytechnic Institute*

16. A single channel time analyzer was constructed which will detect

the pulse of beam current on the target of a Cockroft-Walton accelerator and, after a fixed delay time will open a channel to record the pulses from a detector. The delay time was continuously variable from 10 microseconds to 100 milliseconds. The duration of the counting interval was continuously variable from 10 microseconds to 10 milliseconds. The time analyzer is used in conjunction with the pulsed neutron program at V.P.I.

A MILLIMICROSECOND TIME-OF-FLIGHT NEUTRON SPECTROMETER

C. I. Hudson, Jr. and W. S. Walker; *University of Virginia*

17. A fast neutron time-of-flight spectrometer was developed to measure the flight time of T(d, n) He^4 neutrons elastically and inelastically scattered from various nuclei. The associated particle method was used to obtain a zero time signal and to reduce background. Energy resolution and limitations of the spectrometer are discussed.

MEASUREMENT OF THE INTERNAL FIELD IN A FERROMAGNET USING POLARIZED NEUTRONS

T. G. Williamson; *University of Virginia*

18. The internal magnetic field in a ferromagnet was determined by measuring the change in the vertical component of polarization of a beam of polarized 3.4 Mev neutrons which had passed through magnetized iron. The beam of polarized neutrons was obtained from the D(d,n) He^3 reaction using 1.0 Mev deuterons on a heavy ice target in a Van de Graaf accelerator. The polarization was found from the right-left asymmetry produced by scatering the beam from a carbon analyser. The feromagnetic substance through which the beam was passed was a 6.7 cm thick piece of vanadium permendur (49% Fe, 49% Co, 2% V) which was placed between the poles of an electromagnet. The magnetic flux density in the permendur was determind by standard ballistic galvanometric techniques and within experimental error agreed with that calculated from the depolarization produced. Thus, within experimental error, the field effective for precessing the spins of fast neutrons is the magnetic flux density *B*. (Supported by the U. S. Atomic Energy Commission and the U. S. Army Office of Ordinance Research.).

PULSE SHAPE DISCRIMINATION AGAINST GAMMA RAYS

H. Funsten; *University of Virginia*

19. A circuit to discriminate between proton and electron scintillations in organic phosphors was built, utilizing saturation between the last dynode and anode of an RCA 6810-A photomultiplier tube. The circuit

was based on the apparent difference in second component decay amplitudes under proton and electron excitation, and achieved a discrimination ratio of around 4,000-1.

SCATTERING OF 3.4-MEV POLARIZED NEUTRONS FROM S CU, AND ZN

G. C. Cobb, H. O. Funsten, and T. G. Williamson; *University of Virginia*

20. Partially polarized 3.4-Mev neutrons were elastically scatered by S, Cu ,and Zn and the right-left asymmetry observed at approximately 15° intervals from 30° to 135°. Using the average polarization of the incident neutrons, ($P_n = -11.5\%$), the elastic scattering polarization of the scatterers, $P_{sc}(\theta)$, was determined for the above elements. The observed polarizations are compared with recently measured differential cross sections. The observed values of polarization for Cu and Zn are similar at all scattering angles as are their differential cross sections. Maximum polarization for these elements occurs at an angle of about 120° and in all three cases is about 35%. (Supported by the U. S. Army Office of Ordnance Research and U. S. Atomic Energy Comm.)

THE THEORY OF ELEMENTARY PROCESSES

Dr. Claude Marmasse; *Hollins College*

21. This theory, devloped in France since 1956, is funadmentally concerned with a statistical approach to the phenomena involved in collective (or multiple) reactions, this last term being understood in its widest sense. When applied to the case of polyelectrolytes, it enables one to prove theoretically the existence of sites of preferential fixation now proved experimentally and it explains the behavior of certain experimental curves (e.g. pk' versus length of the chain). The axiomatic presentation is developed.

SCINTILLATION OF SATELLITE RADIO SIGNALS

James D. Lawrence, Jr.; *University of Virginia*

22. Signals from satellite 1959 Iota recorded over a six month period have been analyzed to determine presence of scintillation. Marked nighttime scintillation is frequently noted; day-time scintillation is only weakly, if at all, observed. The appearance of scintillation of the satellite signal shows an almost one to one correspondence with the occurrence of scintillation of the radio source in Cassiopeia at 39 mcs. There is some evidence of the southern latitude limit of the layers responsible scintillation preivously described by Swenson and Yeh.

In addition, the records indicated above have been analyzed to determine a fading rate of the satellite signal. Since many unknown modula-

tions appear on the 20 mc signal of 1959 Iota, a fading rate has been difficult to determine. In certain instances a fading rate of several cycles per second is evident which is in agreement with results previously announced.

ANGULAR SCINTILLATIONS OF RADIO STARS

James Hollinger; *University of Virginia*

23. Equipment and proceedure used in making measurements of the phase scintillations imposed by the ionosphere on radiation from a radio star are described. Measurements were made at 81.5 mc/sec. with a phase switched interferometer which had an aerial separation of 95 wave lengths. Results showed irregularities in phase of two types: (a) random irregularities with a magnitude of 2-3 minutes of arc which correlated well with amplitude scintillations (b) total shifts in phase of up to 7-8 minutes of arc which persisted for periods of up to ¾ of an hour.

A NEW LOOK AT PERTURBATION IN CELESTIAL MECHANICS

D. Willard; *Virginia Polytechnic Institute*

24. Experience has shown that students with a background in physics appreciate an approach to the equations of perturbed planetary motion more direct than that which is available in celestial mechanics texts. Such a presentation is described here, leading to equations of the form

$$\frac{dA}{dt} = \omega \times A$$

Where A is any unit vector and w a function of the perturbing force which has two advantages: (a) it displays the effects of an arbitrary force without reference to any particular coordinate system and (b) it can be rapidly computed by machine techniques.

ATMOSPHERIC PHENOMENA AT A SUNRISE TOTAL ECLIPSE OF THE SUN

John W. Stewart; *University of Virginia*

25. The author and his father traveled to Massachusetts in order to observe the sunrise total solar eclipse of 2 October 1959. Unfortunately heavy clouds prevented a view of the eclipse itself, but th phenomnon was nevertheless quite striking. As totality approached the general illumination faded gradually as if by the dimming of the house lights of a gigantic theater. By contrast at the end of totality the light returned abruptly as the moon's shadow "went to the ground." During the seconds of totality a clear patch of sky on the western horizon

unexpectedly turned a deep red color. Apparently this effect has not ben reported at previous eclipses.

RECENT HIGH PRESSURE STUDIES OF SOLIDIFIED GASES

John W. Stewart and James N. Boyd; *University of Virginia*

26. Compressibilities at constant temperatures for solidified H_2S and SiF_4 have been determined over the range in pressure 0–20,000 atmospheres. Direct piston displacement technique was used. First order phase transitions appear as discontinuities in the volume; second order transitions appear as discontinuities in $(dV/dP)_T$. H_2S exhibits three solid phases. The transitions occur at 103.6°K and 126.2°K at atmospheric pressure. The pressure-volume phase diagram was obtained. SiF_4 shows three solid phases. The triple point was extrapolated to be at 123° K, 11,200 kg/cm². Solidified SiH_4 is being studied at present. The pressure apparatus and the temprature control system are described.

APPARATUS FOR THE MEASUREMENT OF THE MAGNETIC ROTATION SPECTRA OF FREE RADICALS PRODUCED BY FLASH PHOTOLYSIS

J. L. Detch, L. Goodfriend, and F. R. Crownfield;
The College of William and Mary

27. Apparatus is described which will be used for detecting changes in the Faraday Rotation of a gas when free radicals are produced in it by flash photolysis. The plane of polarization of light passed by a Glan-Thompson prism is rotated by the gas in a magnetic field. This light is extinquished by a second Glan-Thompson prism in the absence of free radicals. The increase in transmission when the gas is exposed to a brief, high intensity flash produced by discharging a capacitor through a Xenon tube or exploding a wire is detected by a photoelectric or photomultiplier cell. (Support given this project by The Research Corporation.)

A DEMONSTRATION OF PHASE AND GROUP VELOCITIES USING A CATHODE RAY OSCILLOSCOPE

F. R. Crownfield, Jr.; *College of William and Mary*

28. A method of displaying two travelling waves of different wavelengths and velocities on an oscilloscope is described. Next, it is shown how to produce th superposition of these waves and display the fact that the resulting waves and their envelope travel at different velocities. Finally, a graphical method of determining these velocities (the phase and group velocities respectively) from these of the component waves is presented.

USE OF A SHOE X-RAY MACHINE FOR AN UNDERGRADUATE LABORATORY IN ATOMIC PHYSICS

J. W. Little; *The College of William and Mary*

29. A "retired" shoe X-ray machine was used for experiments to be performed in undergraduate laboratory. Laue spots of several crystalline materials were obtained in about ten minutes exposure. Double scattering from carbon blocks demonstrated the polarization of the radiation. The radiation was detected in a Geiger tube. Satisfactory counting statistics were obtained in fifteen seconds. Since this machine has an on time of about thirty seconds, the timing cycle did not have to be changed.

AN UNDERGRDUATE NUCLEAR PHYSICS EXPERIMENT ON THE SPECTRUM OF A BETA EMITTER

L. Rogon, and J. L. Detch; *The College of William and Mary*

30. This paper presents an experiment on Beta decay which can be performed in an undergraduate laboratory. The pulse height spectrum of a Beta emitter ($_{81}Tl^{204}$) was obtained by means of a plastic scintillator, cemented from two pieces, with the source in between. Calibration was made assuming a linear relation between the pulse height and energy, and using the Compton recoil electron spectrum from Ba^{137} 0.661 Kev gamma ray. Tables of the Fermi function were used to make a Fermi (Kurie) plot to determine the end point energy and verify the Fermi theory. Suggestions are made as to the qualities desired in a source of Beta rays for this experiment, in order to simplify interpretation and improve the accuracy.

A GENERAL PHYSICS LABORATORY EXPERIMENT OF THE BLAMER SERIES OF HYDROGEN

R. E. Adelberger; *The College of William and Mary*

31. A simple grating spectrometer suitable for home construction is described, together with its use in determining the Rydberg constant from the Hydrogen ($H\alpha$, $H\beta$, $H\gamma$) spectrum. Three lenses, a slit, and an inexpensive plane replica grating are used, with a smiple linkage which gives scale readings proportional to wavelength.

SECTION OF BACTERIOLOGY

INCIDENCE OF BACTERIAL SPECIES ISOLATED FROM URINARY TRACT INFECTIONS

H. J. Welshimer; *Medical College of Virginia*

1. Of the 200 bacterial isolants cultured from the urinary tract of 173 patients, *Escherichia coli* was found to be the most frequently occurring organism and was isolated 66 times. Aerobic streptococci, *Aerobacter aerogenes*, *Proteus vulgaris*, and *Pseudomonas aeruginosa* were isolated 33, 27, 26 and 24 times respectively. Nine other species were isolatd in 1 to 7 instances. Although the urinary tract infections were most frequent in females, the number of mixed infections were proportionately higher in males than in females.

A TECHNIQUE TO PROCURE LUNG MACROPHAGES

Eva Soto Leake; *University of Virginia*

2. Rabbit lung macrophages can be easily procured by washing them out with balanced salt solution injected into the trachea. An average of 0.1 to 0.2 ml. of packed cells is obtained from the lung of a normal rabbit. The population of cells is homogeneous, the contamination with red blood cells is minimal, and their viability exceeds 90%. These macrophages are able to engulf heat killed tubercle bacilli when tested for phagocytosis in tissue culture. Cells resembling rabbit lung macrophages were washed out from the lungs of mice, rats and guinea pigs.

HISTOBACTERIOLOGY, THE STUDY AND IDENTIFICATION OF MICROORGANISMS IN FIXED TISSUE BY FLUORESCENT ANTIBODIES

J. D. Marshall and P. Arne Hansen; *Armed Forces Institute of Pathology, Washington, D. C., and Microbiology Department, University of Maryland, College Park.*

3. The feasibility of using the fluorescent antibody technic to differentiate several closely related bacterial species in formalin fixed paraffin embedded tissues was studied. Animals were exprimentally infected with *Pasteurella anatipestifer*, *P. multocida*, *P. novicida*, *P. pestis*, *P. pseudotuberculosis*, and *P. tularensis*. Tissues were taken at autopsy and processed for routine histological examination. Unstained sections were treated with fluorescein conjugated immune sera prepared against each species of *Pasteurella* and examined by ultraviolet microscopy. Organisms and masses of degenerative antigenic material within the tissues stained brightly when homologous serum was used, but not when heterologous sera were

used. In lesions containing 2 or more speciese of bacteria, differentiating the species under investigation was not difficult. Correlation between specific histological changes, with a single species of bacteria was possible.

TUBERCULOSTATIC ACTIVITY OF ALVEOLAR MACROPHAGES

Shunsaku Oshima; *University of Virginia, School of Medicine*

4. This report describes some studies on the extracts obtained from the macrophages washed out of the lungs of vaccinated-challenged rabbits including the tuberculostatic activity of these extracts and purification studies on carboxy-methyl cellulose columns. These data indicate that the main tuberculostatic factor in the lung macrophage extracts appears to be lysozyme.

THE USE OF IODINE FOR THE DISINFECTION OF INDOOR SWIMMING POOLS

J. E. Faber, J. D. Marshall, and William Campbell; *University of Maryland*

5. An 18-week investigation comparing chlorine and iodine disinfection of indoor pool water was conducted. Free and available chlorines, 0.0 to 2.0 ppm, gave a coliform MPN of 240/100 ml to 0/100 ml and plate counts as high as 1380/ml. Minimal iodine in the presence of free and available chlorine yielded no coliforms, no fecal streptococci, and minimal total plate counts. With a deck drain cross-connection introduced, counts ranged to 2400/ml. Free iodine levels from 1.0 to 4.0 ppm yielded no coliforms, no fecal streptococci and negaitve plates. With the cross-connection, up to 70/ml total counts were obtained. Normal iodine levels from 0.4 to 0.8 ppm permitted no coliform, no fecal streptococci, and total counts from 0 to 106/ml. With the cross-connection, the count rose to 3100/ml. A power failure stopped the recirculation system for 24 hours permitting an inadvertent positive contamination control, resulting in a coliform MPN at 240/100 ml; fecal streptococci, MPN at 10/100 ml; and total counts, TNC. The lack of eye and nose irritation during iodine disinfection schedules was statistically significant. Sixty percent of those polled preferred iodine treatment, 10 percent preferred chlorination, and the remainder indicated no preference. erence.

THE PROPERTIES OF A STRAIN OF HERPES SIMPLEX VIRIS WHICH PRODUCED UNUSUALLY LARGE MULTINUCLEATED GIANT CELLS IN TISSUE CULTURE

Clayton E. Wheeler and Charles M. Canby;

University of Virginia, School of Medicine

6. During the course of a previous experiment which involved growing HF herpes-infected HeLa cells in human serum containing antibody to the herpes simplex virus, the character of the plaque formed by the virus in one set of cultures had changed. A plaque composed of very large multinucleated giant cells was constantly produced instead of the usual small giant cell plaque. The new strain of virus, designated HPF, is immunologically identical with the original HF virus. The HPF strain produced mild, barely demonstrable keratitis without encephalitis in rabbits whereas the original HF strain produces severe kerato-conjunctivitis with encephalitis which is often fatal. Rabbits can be immunized against the virulent HF strain by using the relatively nonvirulent HPF variant. HPF is less virulent than HF when treated by intracerebral inoculation in mice. Other properties of the HPF strain will be presented. It is thought the HPF strain may be useful in immunologic procedures and genetic studies.

SECTION OF BIOLOGY

THE BLESSED THISTLE (*Cnicus benedictus*, L.) IN VIRGINIA

A. B. Massey; *Virginia Polytechnic Institute*

1. The blessed thistle, of the family Compositae, is an introduction from Europe. Fernald (Rhodora 46:158) questioned the persistance of it in Virginia and its inclusion in the flora of the State. He found it in a field near Petersburg one season but not in the following year.

We have specimens in the V. P. I. Herbarium collected from April to July in Buckingham, Westmoreland, Albemarle, Shenandoah, Nansemond, Henrico, Accomac, Mecklenburg and Amherst (2 collection 1944, 1947 from same farm) Counties. Fernald records it in Dinwiddie County. Rosete stages in dormant season from Accomac (December) and Franklin (October) Counties are in the Herbarium. The species has been known in Virginia for more than 30 years; however, the oldest specimen in the V. P. I. Herbarium dates back to 1944.

It is very evident that the species has become well naturalized in Virginia and can properly be included in the flora of the State. The range as given in Grays Manual 8th Ed is "Roadside and waste places, rare, N. B. to Ill., and southwest."

A *Zephyranthes* COMPLEX OF THE MEXICAN PLATEAU

Raymond O. Flagg; *The Blandy Experimental Farm*

2. A *Zephyranthes* complex in the mountainous area of central Mexico

is best known from collections in the State of San Luis Potosi. Examinations of plants collected by Mr. and Mrs. Moris Clint and of others collected by W. S. Flory indicate a close affinity between *Z. clintiae* and *Z. Fosteri*. *Zephyranthes erubescens, Z. Lindleyana, Z. macrosiphon* and other taxa seem to be involved. Hybridization, introgression and possibly polyploidy and apomixis have played major roles in the development of this complex.

A 60-CHROMOSOMED *Allium* FROM TEXAS

W. S. Flory and Rina Varma; *The Blandy Experimental Farm, University of Virginia*

3. *Allium Coryi* M. E. Jones is a yellow-flowered onion from the mountains of Trans-Pecos Texas with 60 somatic chromosomes. This is a new number for the genus, and one of the largest chromosome numbers known for *Allium*. The chromosomes vary from just under 2 to just over 6 microns in length, mostly from 4 to 6 microns long. Four pairs, including the longest and the shortest ones, have centromeres that are nearly median in position. The others have centromers that vary from submdian to almost subterminal in location.

THE GENUS *Beaucarnea*: (1) CHROMOSOMES AND (2) SYSTEMATIC POSITION

W. S. Flory and Rina Varma; *The Blandy Experimental Farm, University of Virginia*

4. Three representatives of *Beaucarnea Lem.* (*Nolina* Michx.) have each been found to have 38 somatic chromosomes. These vary from about 2 to well over 7 microns in length. Several of them are decidedly longer than the others. The numbers, and to some extent the make-up of the chromosome complements, are reminiscnt of th cytological set-up in certain of the Agavaceae. These factors, coupled with morphological characters, and habitat indicate the genus as being more correctly placed in Agavaceae than in Liliaceae.

SOME PROPERTIES OF A GROWTH INFLUENCING SUBSTANCE IN TIMOTHY ROOTS

Robert T. Brumfield; *Longwood College and Oak Ridge National Laboratory*

5. The root cap of timothy roots is covered by a transparent gelatinous substance which has certain growth effects. Water extracts of the substance modify the absorption spectrum of indole-3-acetic acid, possibly by the formation of a new complex, and the magnitude of the shift is influenced by UV in proportion to the dosage. The spectrum of 2,4,

6-trichlorophenoxyacetic acid is modified when mixed with extracts of the substance but the shift is not influenced by UV. These results are of interest since 2,4,6-T inhibits the growth effects of UV while IAA does not. (Supported by the Atomic Energy Commission and the National Science Foundation).

DO WE NEED A GEOBIOTIC ETHIC?

Joseph J. Shomon; *Commisison of Game and Inland Fisheries*

6. The concept of a geobiotic ethic, its meannig, importance, and need is introduced. Such topics as our dwindling natural resources, the growing and shifting human population and its wants, and the necessity of preserving some semblance of our natural environment in an ever increasing technological social order are treated. To maintain balanced order, it seems apparent to some, but not many, that we stand to lose much that is democratic and American unless we evoke and ever enlarge a genuine ecological conscince in our people. Those in the scientific, educational, and other professional fields can do much to bring this about.

PRELIMINARY STUDIES ON THE FEEDING RESPONSE OF REDWINGS TO 27 GRAIN SORGHUM VARIETIES

Paul W. Lefebvre; *Virginia Polytechnic Institute*

7. Tests were conducted to determine whether a technique designed to test corn resistance to blackbird attack could be modified for use in finding grain sorghum varieties which might be so resistant. Use of the modified technique in preliminary tests sems to indicate that the procedure is effective and that several varieties of grain sorghum are bird-resistant to varying degrees.

EVALUATING RABBIT MANAGEMENT PROCEDURES BY PELLET COUNTS

Alan S. Krug; *Virginia Polytechnic Institute*

8. Summer utilization by the cottontail rabbit of various areas receiving different land-cultural treatment was measured by pellet counts. Following this, a study was instituted to determine the longevity of pellets and the effect that this longevity would have on land-cultural treatment evaluations done later in the year. It was found that pellet counts in late fall and winter are markedly influenced by pellets deposited earlier in the season, and such counts may therefore give erroneous impressions.

DEVELOPING A TECHNIQUE FOR SAMPLING BROWSE PRODUCTION ON DEER RANGES

Jim B. Whelan; *Virginia Polytechnic Institute*

9. A study concerned with the development of a weight technique for sampling the quantity of browse available to the White-tailed Deer. The problem objective was to determine correlation between quantity of available browse and site quality measurements. At present, clipping and weighing the annual growth of browse plants on sample plots is the most accurate means of determining production and yield. On sample plots if a significant correlation exists between weights of browse clippings and several measures of site quality, then these site quality measurements by themselves could serve as a reliable estimate of the browse yield.

VARIATIONS IN THE CRAYFISH *Cambarus montanus acuminatus*

Lary L. Farmer; *University of Virginia*

10. Studies of variation of selected body parts were made using the Student's t-test and the analysis of variance test. From this data relatively smooth north-south and east-west clines could be esablished for each of the measurements taken. Previously those populations occurring in the eastern part of the range had been considered a different subspecies from those in the western part of the range. Since no definite breaks occur in the clines, this designation is considered invalid.

FUNCTION OF THE CILIATE MICRONUCLEUS 4URING ASEXUAL REPRODUCTION

Carolyn Wells; *Longwood College*

11. X-Irradiation studies of strain EU 6000, *Tetranymena pyriformis*, indicate that the recovery of viable amicronucleate clonal populations is rare although many amicronucleate cells are found among surviving progeny. Attempts to introduce micronuclei into cells of a radiation-produced amicronucleate clone by conjugation have been made. Micronucleate lines are obtained from amicronucleate pair members only in low frequency. The results, considered with those of other workers, suggest that some change in the state of the cell, additional to the physical loss (or gain) of the micronucleus, must occur before viable amicronucleate clones can be obtained from micronucleate cells, or before amicronucleate cells can produce viable micronucleate linages. The results further imply that the ciliate micronucleus unquestionably contributes information to the cell during asexual growth and reproduction. (Work performed at the Biology Division, Oak Ridge National Laboratory).

RESISTANCE TO DDT AND CHLORDANE IN THE GERMAN COCKROACH FOLLOWING DISCONTINUANCE AND RESTORATION OF SELECTION

James McD. Grayson; *Virginia Polytechnic Institute*

12. Discontinuance of selection resulted in initial apparent rise in resistance in both strains, followed by rapid loss of resistance after third generation in DDT strain but slow, gradual loss in chlordane strain. Restoration of selection resulted in rapid increase in resistance in chlordane strain but slow increase in DDT strain.

THE ALBINISTIC ISOPODS OF THE UNITED STATES

Harrison Ross Steeves III; *University of Virginia*

13. The distribution of the albinistic isopods is both widespread and at the same time peculiarly limited. The characteristic habitat is a limestone cave with a sufficient water supply. Due to new evidence, the albinistic isopods have now been placed in the Genus *Asellus*. The present system of classification is almost entirely based upon the secondary sexual characteristics of the tip of the endopodite of the second pleopod and the armament of the palmar region of the propodus of the male gnathopod.

A STUDY OF THE MICROENVIRONMENT IN TWO CONTRASTED FOREST FLOOR HABITATS

James K. Grimm; *Madison College*

14. A study of hte microenvironment in two contrasted forest floor habitats was made to determine the microenvironmental factors. With special reference to gradients, as well as to averages and extremes, the conditions or combination of conditions operating to control the population of the organisms under investigation were also determined. Various mechanical devices were used to record the physical factors which tend to regulate the activities of the organisms found in the litter of the areas investigated. Samples of leaf litter were taken daily and the organisms extracted to determine kinds and numbers found under varying physical elements.

GASTROTRICHAN STUDIES AT MOUNTAIN LAKE BIOLOGICAL STATION, GILES COUNTY, VIRGINIA, JUNE-AUGUST 1958

Charles E. Packard; *Randolph-Macon College*

15. One hundred and seventy-six individual specimens were isolated from samples of numerous collections from widely different sites in Vir-

ginia and West Virginia with morphological, developmental and ecological data taken. Representatives of the genus *Chaetonotus* were most abundant. *Ichthydium, Lepidodermella, Polymerurus,* and *Heterolepidoderma* were less prevalent. Many stations yielded no individuals at all. Mountain Lake itself and Farrier's Pond near Newport had fairly rich faunas. The investigation constitutes what is planned as an extensive coverage of gastrotrichs for these two states.

MORPHOGENESIS OF PET/MCV MOUSE MELANOCYTES

Willie M. Reams, Jr. and Stuart E. Nichols, Jr.;

Medical College of Virginia

16. The pigment cells found in the connective tissues of PET/MCV mouse embryos generally begin melanogenesis well before they have assumed their definitive dendritic shape. In contrast to the melanocytes within the skin, these internal melanocytes readily lend themslves to experimental investigation. The data obtained from grafting interal melanocytes into chick embryos suggests that the morphogenesis of pigment cells is brought about by a mechanism similar in its action to a hormone. A concept of morphogenetic hormones was proposed. (Supported in part by the National Institute of Health and by the National Science Foundation. *Medical Student Fellow of the National Foundation and U.S.P.H.S.)

THE EFFECT OF NA-L-THYROXINE ON VIABILITY AND REGENERATION OF *Dugesia tigrina*

William L. Mengebier; *Madison College*

17. Segments of *Dugesia tigrina,* formed by sectioning the animals through the mid-pharyngeal region, exhibited a reduced mortality rate when placed in 3.13×10^{-5} M Na-L-Thyroxine. Formation of the blastema and rates of regeneration of individual segments were increased by the addition of the thyroxine salt. Treatment with phenyl alanine had no effect on either the mortality rate or the regenerative process. The addiion of cortison acetate inhibited regeneration and increased the mortality rate. The effects of vertebrate hormones on invertebrates was discussed.

HISTOLOGICAL OBSERVATIONS OF THE OVIDUCT OF *Cambarus longulus longulus* (GIRARD 1852)

D. Hugh Puckett; *College of William and Mary in Norfolk*

18. A study of the oviduct of *Cambarus l. longulus* (Girard 1852) revealed that changes associated with the reproductive cycle occur in the oviduct of this species. These changes involve differences in the his-

tological nature of the epithelium of the oviduct before and after egg laying marked by differnces in the position of the nuclei, the secretary activity, and the nature of the limiting membranes of the epithelial cells. Various staining techniques indicate the presence of glycogen and other polysaccharides in the epithelial cells and in the lumen of the oviduct. A description of the connective tissue coat of the oviduct and oviducal orifice was presented.

T–1824 Dye Light Absorption Characteristics in Deproteinated Plasma

Jack D. Burke; *Department of Biology, University of Richmond*

19. The absorption spectra of two T-1824 (Evans Blue) dye solutions were determined on a Beckman Spectro-photometer in the wave-length range of 500 to 700 millimicrons. Wave-length was plotted against optical density. One absorption wave was determined on a dye in water solution. Another curve was determined on a deproteinated plasma sample tagged with the dye during blood volume determinations on swine. A comparison of the two curves portrayed graphically revealed a peak absorption at 620 millimicrons. Thus, the validity of blood volume determinations using T-1824 dye increases when this parameter is known and controlled at peak transmittance.

QO_2 Studies in the Horned Passalus

James R. Powell; *University of Richmond*

20. The rate of oxygen consumption in a sample of *Passalus cornutus* Fabricius was measured in regard to body weight and expressed in terms of QO_2. QO_2 and body weight in *Passalus* were found to be related by the equation $QO_2 = (k)\ \text{Body Weight}^{-0.88}$ which is in accord with the surface law of Sarrus and Rameaux.

SECTION OF CHEMISTRY

Quantitative Determination of the Major Polyphenols in Tobacco

Marvin D. Edmonds and W. Allan Powell, *Philip Morris, Inc. and University of Richmond*

1. A paper chromatographic method for the quantitative determination of individual polyphenols in tobacco was described. The polyphenols were measured spectrophotometrically as colored reaction products with Folin-Ciocalteu reagent. The colorimetric procedure deepnds upon the reduction of compounds containing sexivalent tungsten and molyb-

denum to colored compounds. The Folin-Ciocalteu reagent was chosen because it allows sensitive detection. It is a fast reactant and it allows one to overcome the interfering background problems obtained when using direct ultraviolet analysis for these compounds.

A STUDY OF THE REDUCING SUBSTANCES IN CIGARETTE SMOKE

J. E. Wickham, Jr., J. C. Holmes, and J. J. Westbrook, III;
Philip Morris Research Center

2. An automated method for the determination of total reducing substances, neutral reducing substances and acidic reducing substances in cigarette smoke was described. The method inovlves examination of the total particulate mater derived from cigarette smoke. Procedures and results were described for the treatment and examination of the total particulate matter so as to yield measurements of the various reducing substance fractions with practical precision.

A MATERIAL BALANCE STUDY OF A BURNING CIGARETTE

Elizabeth T. Oakley, Melvin B. Bennett, and Joseph C. Holmes;
Philip Morris Research Center

3. An apparatus and procedure were described for the collection and weighing of all the fractions of a cigarette smoked under standard smoking conditions. The fractions were defined as the butt, ash and smoke. The smoke was further fractionated into mainstream and sidestream particulate matter, carbon dioxide and other gases. The precision of replicate analyses was extremely good and the accuracy of the method was excellent .

THE DETERMINATION OF BORIC ACID BY CONDUCTIMETRIC MEASUREMENT

Carol A. Penn and Helen L. Whidden; *Randolph-Macon Woman's College*

4. Several methods described in literature for determining boric acid were either inapplicable for the desired concentration range (0 to 10 parts per million) or required too long an operation time. Addition of mannitol to boric acid converts it to a complex more highly ionized than boric acid and suited to conductimetric measurement. Measurements on several boric acid-mannitol solutions were made made ,and a calibration curve (concentration versus conductance) was prepared. Preliminary results showed that boric acid can be determined quantitatively by this method. Details of experimental procedure were worked out by studying the following factors: (1) effect on conductance of varying excess amounts of mannitol, (2) the degree of ionization of the boric

acid-mannitol complex and (3) viscosity effects on conductance of the different complex concentrations.

A COMPARATIVE STUDY OF AVAILABLE TITRIMETRIC METHODS FOR URANIUM

Gayle King and Helen L. Whidden; *Randolph-Macon Woman's College*

5. The most commonly used volumetric method sfor determining uranium involves: (1) the reduction of uranium to a mixture of U(IV) and U(III) in a Jones reductor, conversion of the U(III) to U(IV) by aeration, addition of ferric ion to quantitatively convert U(IV) to U(VI), and subsequent titration of the resulting ferrous ion with standard potassium dichromate or ceric solutions; or (2) reduction of uranium to U(IV) in a lead reductor followed by titration with a standard ceric solution. A repetition of the procedures was carried caried out since investigators attempting to explain the varying titres and evaluate the methods arrived at different conclusions. Pure U_3O_8 samples were used to determine the dichromate and ceric titres. A comparison was made of the uniformity of results as to ease and accuracy and the methods were evaluated by analyzing the recovered uranium.

A NEW SPECTROPHOTOMETRIC METHOD FOR THE DETERMINATION OF MICROGRAM AMOUNTS OF MANGANESE

Dwight O. Miller and John H. Yoe; *University of Virginia*

6. The method is based on the absorbance of radiant energy by a complex which is formed by the reaction of manganese (II) with benzohydroxamic acid in an ammoniacal medium. The reaction conditions are critical and the determination may also be carried out in nonaqueous solvents. The senitivity is 0.016 p.p.m. at 544 m μ and at this wavelength, the reagent does not absorb, permitting a water blank to be used. An ion exchange technique was employed for the separation of interfering ions. The analysis of a variety of National Bureau of Standards samples and synthetic mixtures showed that the method is accurate. The probable structure of the absorbing specie was discussed.

COMBUSTION OF ELEMENTAL BORON

Claude P. Talley; *Experiment Incorporated*

7. Boron rods of high purity were prepared and subsequently heated by electrical resistance heating in various gases, so that the burning rate could be measured under controlled conditions. Relatively slow reaction rates were followed by measuring volumetrically the uptake of oxidant gas at constant pressure as a function of time. Faster rates were

followed by measuring the change in dimensions with time of the solid boron as it was consumed. At high temperatures, combustion in pure oxygen and certain other gases was self-sustaining and electrical heating was not required after ignition. Various rate-limiting steps were indicated for the oxidation of elemental boron in pure oxygen over a wide range of temperature and pressure. In four different regions, transport of some species appeared to be the rate-limiting step, while in a fifth region, chemical reaction may have been the slow step. In two of the regions, transport by liquid flow or gas-phase diffusion of boron oxide was rate-limiting. In the other two regions, evaporation of elemental boron is expected to be rate-limiting in one case and diffussion of oxygen in the gas phase in the other case.

PREPARATION AND PROPERTIES OF MASSIVE AMORPHOUS ELEMENTAL BORON

Claude P. Talley, Lloyd E. Line, Jr., and Quinton D. Overman, Jr.;
Experiment Incorporated

8. Massive amorphous elemental boorn was prepared by reduction of BBr_3 vapor by H_2 in the vicinity of an incandescent tungsten filament 25 μ in diameter. Information on the kinetics of the process was obtained. The deposition appartus was constructed from Pyrex glass and Teflon fittings in order to prevent contamination from stopcock greases. Boron rods up to 2 mm in diameter and 5 to 10 centimeters in length were obtained. Boron deposits in the shapes of spheres, hemispheres and cones were also observed. Wet chemical analysis of a 1-mm-diameter rod for total boron indicated a boron content of 98.8%. This type of boron is called amorphous because X-ray diffraction paterns revealed only two diffuse rings. Amorpohus boron rods showed high tensile strength and Young's modulus (2.3×10^5 to 3.5×10^5 lb/in.^{2} and 64×10^6 lb/in.^{2}, respectively). The density was determined by a flotation technique and found to be 2.350 gm/cm^3 $\pm$ 0.005 gm/cm^3. This material is very hard and can scratch sapphire. Amorphous boron shows a relatively high resistivity and high negative temperature coefficient of electrical resistance ,a characteristic of crystalline boron and semiconductors in general. It also is very opaque in the visible but can be crystallized by proper heat treatment into other modifications including one which transmits a considerable amount of red light.

ISOLATION AND CHARACTERIZATION OF GNAPHALICIN, AN ANTIBIOTIC ISOLATED FROM *Gnaphalium obtusifolium* (RABBIT TOBACCO)

Samuel J. R. Gamble; *Lynchburg College*

9. An antibiotic principle was isolated from. *Gnaphalium obtusifolium*, commonly known as as Rabbit Tobacco. An ether extract of the leaves gave a water insoluble fraction which is active against *Bacillus subtilis*.

KINETICS OF THE HYDROLYSIS OF NITROSTYRENES

Thomas I. Crowell; *University of Virginia*

10. The reversal of the nitrostyrene synthesis proceeds through the nitroalcohol to aldehyde and nitromethane. Kinetic studies in aqueous buffer solutions at 25°, in the pH range 1.5 to 8, showed consecutive first-order reactions. The first step, which is reversible, showed general base catalysis; however, the rate is not linear in the base concentration. The rate of the second step depends only on pH.

A TECHNIQUE FOR THE CONTINUOUS MEASUREMENT OF THE VAPOR PHASE CORROSION OF MEALS

William H. Jago and Nelson F. Murphy; *Virginia Polytechnic Institue*

11. Two sensing systems were used in the continuous measurement of the vapor phase corrosion of metals: (1) a linear variable differential transformer (LVDT) and (2) a modified analytical balance. The LVDT functioned as an electro-mechancial transducer by the movement of a magnetic core which caused a voltage proportional to the core displacement to be produced in the secondary winding of the transformer. After calibration, the LVDT readings were recorded continuously on a strip chart. The left-hand pan support of an analytical balance served as the movable end of a glass rod second-class lever. After zeroing the balance, readings were taken from the milligram scale. The metallic samples were suspended either from the lower cantilever supporting the LVDT core or from the center of the glass rod lever. The essential features of the corrosion reacto were a three-necked, 500 milliliter flask submerged in a four-liter constant temperature bath, a glass strand from which the metallic samples were suspended and either a water-cooled condenser for atmospheric tests or a gas inlet reducer for special atmosphere tests. The bottoms of the metallic samples were suspended five centimeters above solutions which produced the desired corrosive vapors in the corrosion reactor.

SOLUBILITY AND EQUILIBRIUM RELATIONSHIPS IN THE SYSTEM WATER–PHOSPHORIC ACID–TRIBUTYL PHOSPHATE

Basil C. Doumas and Nelson F. Murphy; *Virginia Polytechnic Institute*

12. Mutual solubility and equilibrium tie-line data for the system water –phosphoric acid–tributyl phosphate were determined at 25.00 ± 0.05°C. Tributyl phosphate was titrated into aqueous phosphoric acid solutions until a distinct organic layer was observed on top of the aqueous phases. The "semi-quantitative" water-rich solubility curve for the system was determined. Seven heterogeneous mixtures of water phosphoric acid and tributyl phosphate were equilibrated at 25.00 ± 0.05°C. and separated

into coexisting phases. Phosphoric acid concentrations of organic and aqueous phases were determined by titration with standard NaOH solution. Organic phases were analyzed for water by titration with Karl Fischer reagent. The organic-rich solubility curve for the system was located by phosphoric acid and water analyses of equilibrium organic phases. The complete solubility curve for the system was not determined since 85 per cent phosphoric acid was used throughout the experimental work as the source of acid. Selectivity diagrams were drawn to show that tributyl phosphate is more selective for phosphoric acid than n-butanol, diethyl ether or 2-hydroxyethyl, n-hexyl ether. Of the four solvents mentioned, tributyl phosphate seems best for separation of phosphoric acid solutions by liquid-liquid extraction.

REPRESENTATION OF DELAY POWDER DATA

Lewis B. Johnson, Jr.; *University of Virginia*

13. A systematic representation of burning data for delay powders was found very useful for many systems. The "phase diagram representation" was followed. For two-component systems, composition was represented as the abscissa on rectangular coordinates and the function of interest as the ordinate. Three-component systems were represented on triangular composition diagrams. Lines of equal heat output were designated "isocals" and lines of equal burning times, "isochrons." Other functions can be represented similarly.

THE BINARY SYSTEM SODIUM ACETATE–PROPIONIC ACID

Robert Hall and Wilbert Chappell; *Madison College*

14. A brief description was given of the method used in preparation of anhydrous sodium acetate and anhydrous propionic acid. Solubilities were determined by the "synthetic or freezing point method." Results were in tabular and graphical forms showing the solubility concentrations in mole per cent of saturated solutions of sodium acetate in propionic acid over a considerable range of temperature. A description was given of the solvates isolated. A comparison of the system investigated and the system "Sodium Acetate–Acetic Acid" was noted.

THE GROWTH OF THIN FILMS OF γ-CuBr ON COPPER SINGLE CRYSTALS

Kenneth R. Lawless and Robert H. Kean; *University of Virginia*

15 Single crystals of copper were exposed at room temperature to a known vapor pressure of bromine and the reaction product was examined by electron diffraction and electron microscope techniques The reaction product was γ-CuBr and was epitaxially oriented on the copper sub-

strate with apparent twinning of the bromide. Carbon replicas of the surface were examined in the electron microscope and showed the surface to consist of small facets. The relative rates of formation of the bromide film were different for different crystal faces, but the magnitude of the differences was apparently small.

ELECTRON MICROSCOPE STUDIES OF THIN NICKEL ELECTRODEPOSITS ON COPPER SINGLE CRYSTALS

Lucille B. Garmon; *Virginia Institute for Scientific Research*

16. Electrodeposited nickel films 100 to 1000 A. in thickness were chemically stripped from the base metal and examined directly in the electron microscope. Twinning was observed on both (100)-oriented films and (111)-oriented films. Comparison between films of different orientations revealed that twinning was usually more extensive on (111)-oriented films. It was noted that the intersection of a twin with the crystal matrix was generally a region of weakness in the film.

THERMODYNAMICS OF AQUEOUS PHENOLS

W F. O'Hara and L. G. Hepler; *University of Virginia*

17. The quantity Δ H° at 25°C. for the ionization of aqueous meta chloro phenol was obtained by combining Δ H° ion of water with values for Δ H° of solution and neutralization of meta chloro phenol, obtained by using a high precision solution calorimeter. Combining this value of Δ H° ion with Δ F° ion, calculated from the literature value of the thermodynamic ionization constant, the value of Δ S° ion was calculated. These values were compared with the the thermodynamic values for the ionization of other aqueous chloro phenols obtained in the laboratory. Similar investigations of other substituted phenols are being carried out.

STUDIES IN THE SYNTHESIS OF A SESQUITERPENE RING SYSTEM

Oscar R. Rodig and Norman J. Johnston; *University of Virginia*

18. A number of naturally-occurring sesquiterpenes, having the ring skeleton I, contain oxygen functions at position two and alkyl residues at position seven. Improved procedures have been developed for the preparation of various intermediates, including II, which can be used in the syntheses of these natural products.

1,6 Additions of various reagents to II provide one of the most facile routes for introducing functional groups at position seven. Studies on these adducts and their relationships to structures of naturally-occurring sesquiterpenes were presented.

SOME INDOLE DERIVATIVES RELATED TO NATURAL PRODUCTS

Walter H. Hartung and A. Garnett Richardson; *Medical College of Virginia*

19. Two analogs of reserpine and four analogs of ergonovine were reported in which tryptamine and certain other functional groups were retained, but the condensed ring structures were replaced by alkyl chains having a sufficient number of carbon atoms to conform to the same spacial paterns as the parent compounds. An indole derivative of nitrogen mustard ,four derivatives of indole-2-carboxylic acid and three indole esters of 2-diethylaminoethanethiol were also reported. The latter have some potential as antiradiation drugs since the efficacy of the free thiol in this respect has already been established.

THE PREPARATION OF TRIALKYL PHOSPHOROTRITHIOITES AND THEIR COTTON DEFOLIANT ACTIVITY

Mathias F. Kelley and William R. Smithey, Jr.; *Virginia-Carolina Chemical Corporation*

20. The trialkyl phosphorotrithioites of a series showed interesting activity as cotton defoliants. Methods of preparation and the physical and chemical properties of the resulting esters were discussed. A preliminary correlation of defoliation activity with molecular structure was made.

BROMINATION REACTIONS OF 2-METHYL-2, 5-DIHYDROTHIOPHENE 1, 1-DIOXIDE AND SOME OF ITS SIMPLE DERIVATIVES

Robert C. Krug and James A. Rigney; *Virginia Polytechnic Institute*

21. Reactions were studied in which 2-methyl-2, 5-dihydrothiophene 1, 1-dioxide; its position isomer, 2-methyl-4, 5-dihydrothiophene 1, 1-dioxide; and the saturated cyclic sulfone, 2-methyltetrahydrothiophene 1, 1-dioxide were treated with bromine, N-bromoacetamide, N-bromosuccinimide or 1, 3-dibromo-5, 5-dimethylhydantion. Products were isolated which have been identified as 4-bromo-2-methyl-4, 5-dihydrothiophene 1, 1-dioxide and 3, 4-dibromo-2-methyltetrahydrothiophene 1, 1-dioxide. Another product has been assigned the structure of 2-bromo-2-methyl-2, 5-dihydrothiophene 1, 1-dioxide on the basis of its reactions and infrared spectrum.

PREPARATION OF SOME CYCLIC SULFONE DERIVATIVES BY THE HYDROBORATION REACTION

Robert C. Krug and Donald E. Boswell; *Virginia Polytechnic Institute*

22. Passage of excess diborane gas through a solution of 3-methyl-2, 5-dihydrothiophene-1, 1-dioxide (I) yields an organoboron compound analogous to a trialkyl borane. Alkaline oxidation of this material pro-

duces an alcohol tentatively identified as 4-hydroxy-3-methyl-tetrahydrothiophene-1, 1-dioxide (II). Acetylation of II yields the coresponding ester ,acetoxy-3-methyl-tetrahydrothiophene-1, 1-dioxide (III), and reaction of II with thionyl chloride produces the corresponding halide, chloro-3-methyl-tetrahydrothiophene-1, 1-dioxide (IV). The physical constants and infrared spectra of II, III and IV were presented.

REACTIONS OF CIS- AND TRANS-DYPNONES

Landry T. Slade and Robert E. Lutz; *University of Virginia*

23. Cis-dypnones were prepared by irradiating solutions of transdypnones. Stereoisomeric epoxides were made. Trans-dypnone adds phenylmagnesium bromide largely 1,4, cis-dypnone, 1,2. Phenyllihtium adds 1,2 to both stereoisomers, giving the same product, 1,1,3-triphenyl-1,4-butadiene. On heating, this gave 1,3-diphenyl-2,4-dihydronaphthalene, which was characterized by conversion to 1,3-diphenylnaphthalene. In evaluating configurational effects on reactivity of the beta-methyl, both stereoisomers were reacted with selenium dioxide giving 2,4-diphenylfuran and with N-bromosuccinimide giving trans-gamma-bromodypnone which resisted irradiation-inversion. Weakly basic morpholine converted trans-gamma-bromodypnone into trans-gamma-morpholinodypnone, but under refluxing into 2,4-diphenylfuran. Sodium acetate gave 2,4-diphenylfuran. Strongly basic sodium hydroxide and methoxide at −10° gave 1,2-dibenzoylethane, involving a novel rearrangement for which mechanism is postulated.

SYNTHESIS AND INVESTIGATION OF HYDRAZIDOOXALIC ACID

Thomas P. Foley, Jr., Thomas C. Imeson, II, David N. Keyes, and James K. Shillington; *Washington and Lee University*

24. Published methods for preparation of hydrazidooxalic acid proved to be unsatisfactory. Research was undertaken for its preparation along simple lines from inexpensive materials. Partial hydrolysis of diethyloxalate yields the ester salt. With hydrazine hydrate, the latter produces the salt of hydrazidooxalic acid. The free acid is obtained by acidification with the mineral acids. A study of the bifunctional nature of the free acid was made. The compound is a very strong acid with the hydraxido group overshadowed by the acid group. Electronically and geometrically, the nature of hydraxidooxalic acid is primarily monofunctional.

THE COUPLING OF GRIGNARD REAGENTS TO BENZYL SYSTEMS

Frank A. Vingiello, Sih-gwan Quo and John Sheridan;

Virginia Polytechnic Institute

25. In contrast to a report in the literature that phenylmagnesium bromide and benzyl chloride did not couple, an excellent yield of diphenylmethane was obtained in this reaction was extended to include various Grignard reagents and various substituted benzyl halides. The literature regarding this reaction was reviewed and the new findings presented.

AN UNUSUAL REDUCTION OBSERVED DURING THE COURSE OF A GRIGNARD REACTION

Frank A. Vingiello and Thomas Delia; *Virginia Polytechnic Institute*

26. During a study of the synthesis of polynuclear aromatic hydrocarbons, 2-bromophenyl-1-naphthyl methane was required. The route chosen for the synthesis of this intermediate involved the reaction between 1-naphthylmagnsium bromide and 2-bromobenzaldehyde followed by the reduction of the hydrol. Quite unexpectedly, it was found that the Grignard reaction itself gave the reduction product 2-bromophenyl-1-naphthyl methane. This unusual reaction was investigated.

THE SYNTHESIS OF SOME NEW 10-SUBSTITUTED-ARYL 1,2-BENZANTHRACENES

Frank A. Vingiello and Claude I. Lewis; *Virginia Polytechnic Institute*

27. In connection with research involving the synthesis of possible carcinolytic agents, two new complex 1,2-benzanthracenes were synthesized. The reaction paths leading to the successful syntheses of these compounds, namely, 10-(4-bromo-1-naphthyl)-1,2-benzanthracene and 10-(4-methyl-1-naphthyl)-1,2-benzanthracene were presented. A discussion of the syntheses of all new intermediates necessary for the preparation of these compounds was presented.

THE ZEEMAN EFFECT IN POLYATOMIC MOLECULES AND THE MAGNETIC ROTATION SPECTRUMS OF No2

P. L. Goodfriend; *College of William and Mary*

28. Classes of electronic transitions which can yield strong Zeeman effects in polyatomic molecules are:, (a) Transitons where both states are linear and $\Delta \Lambda \neq 0$; b) Intercombinations; (c) Transitions between bent states and linear states with $\Lambda \neq 0$; (d) Transitions involving a state perturbed by a magnetic state or coupled to the nuclear framework. A strong magnetic rotation spectrum implies a strong Zeeman effect. The magnetic rotation spectrums of NO2 at four field strengths were studied. Its extent, intensity predominance of 650 cm^{-1} intervals and

its variation with field strength indicate a class (c) transition. Using theoretical considerations, $a^2\pi \leftarrow {}^2A_1$ transition was assigned to the visible system.

SECTION OF ENGINEERING

A Miniaturized Generating Electric Field Meter

F. E. Moss, R. R. Humphris, B. J. Gilpin; *University of Virginia*

1. Electric fields emanating from aircraft, rockets and satellites have been measured both in this county and abroad. Recent studies of the electrical interactions between space vehicles and environments containing free charges, such as the ionosphere and the Van Allen Radiation Belts, have brought renewed interest in instrumentation capable of measuring surface electric fields and ion currents impinging on rockets and satellites. The electric field meter described herein consists of a small probe exposed to the field and ion current on the surface of the vehicle. This probe is alternately opened and closed by a motor-driven, grounded shutter so that the electric field and ion current impinging on the probe are chopped into a-c components. If a resistor be connected from the probe to the body of the vehicle, then voltage components proportional to the external field and ion current are generated across the resistor. The instantaneous generated voltage due to electric field is proportional to the time rate of change of probe area, while the voltage due to ion current is proportional only to exposed probe area. Thus, the field and ion current components may be separated by synchronous detection and are measured independently by the instrument.

An A-C Ionization Chamber

W. P. Walker, R. R. Humphris and C. D. Broadbent;
University of Virginia

2. An ionization chamber using an alternating ion collection voltage (a-c chamber) was conceived for the use of an a-c system with high gain and narow bandwidth. The average ionization current should be equal to the d-c ionization current of conventional chambers. However, results of an experimental chamber showed that at an average collection voltage less than the voltage required for complete ion collection during each half cycle, there was a large apparent increase in ionization current. A current amplification can be achieved by allowing some of the ions to remain in the chamber and oscillate with the collection voltage. This current or the amplification, is a linear function of the frequen-

cy, ion production rate, and area of the collecting electrode, but varies as the cube of the electric spacing. This study of the a-c chamber shows that it has great promise for the future and has the following advantages: (1) Current amplification is obtained. (2) The time constant, or ion-concentration half-life, observed experimentally is approximately one-half second, and is very short when compared to conventional chambers. (3) A-c coupling may be used, thus eliminating stability and drift problems. (4) The a-c chamber is simple to zero-adjust, even in the presence of ionizing radiation (5) Appreciable variations in a-c collection voltage may be experienced without significant change in signal level.

Design of a High Temperature Continuous Run Eectric Arc Wind Tunnel

William Grossmann, Jr.; *Virginia Polytechnic Institute*

3. First results of an effort to produce high temperature gas flows with accurate scale flow simulation are presented. An electric arc wind tunnel, capable of producing stagnation temperatures up to 15,000 °R (at low pressures) was proposed and a full scale pilot model electric arc facility already completed was described. Theoretical calculations assuming air to be in equilibrium even at extreme temperatures were made in order to predict properties of the flow for varying stagnation conditions and results of this analysis are presented. Calibration of the electric arc facility was discussed, based upon the fact that atomic spectral lines tend to broaden out due to high temperatures and a definite shift in the position of the line of maximum intensity occurs resulting from mass motion of the gas. Description of intended future use of the electric arc win dtunnel included such topics as: (1) aerodynamic force tests in high speed dissociated gas flow, (2) magnetoaerodynamic studies, (3) qualitative studies of chemically reacting gas flows.

Detection of Radioactive Argon from the University of Virginia Nuclear Reactor

J. K. Gilham; *University of Virginia*

4. Neutron iradiation of air inside reactor facilities produces radioactive argon by the (n,y) reaction:

$$ {}_0n^1 + {}_{18}A^{40} \rightarrow {}_{18}A^{41} $$

followed by T

$$ {}_{18}A^{41} \rightarrow {}_{19}K^{41} + \beta^- + \gamma $$

with a half life of 112 minutes. This radioactive argon is discharged through tall chimneys, diluting the radioactivity in the atmosphere. Manitoring radioactive argon presents special problems since argon cannot

be filtered, adsorbed or absorbed. The radioactivity discharged in the atmosphere will be monitored by a Geiger tube suspended in the ventilation ducts lading to the chimney and will be constantly recorded on a quantitative Geiger counter scaler. Components for this system are readily available; thus providing a simple, inexpensive monitoring system. Radioactive argon once dispersed in the atmosphere is monitored by a low background beta counter using specially constructed planchets. This device will detect levels of radioactivity above one-tenth maximum permissible dosages. Attempts to measure dosages below this level have, to date, met with little success.

NUCLEAR DESIGN OF A THEMIONIC CONVERTER REACTOR

David J. Paul; *University of Virginia*

5. The Los Alamos Plasma Thermocouple consisted principally of a uranium carbide rod ¼ inch in diameter suspended in a stainless steel cylinder of 1 inch outer radius and 1/8 inch walls. This device was lowered into a critical reactor whereupon fissions occurred in the uranium carbide and its temperature rose to 1500°C. The stainless steel walls of the cylinder were maintained at 300°C by convective cooling with oil. Conceivably an appropriate arrangement of such thermocouple tubes with a moderator-coolant flowing between them could form a nuclear reactor. This would produce d-c electricity free of heat exchanger and a-c generation equipment costs and have theoretical overall plant efficiencies of a phenomenal 40 per cent if the a-c and d-c production are both considered. A core of 4 ft. diameter and 4 ft. height would have the following power characteristics: Total fission power out—3 megawatts; Thermal power out—2.4 megawatts; A-C power out—0.6 megawatts; D-C power out —0.6 megawatts. The temperature of the steam going to the turbine was calculated to be 600°F and the temperature change across the core 43°F.

PERFORMANCE CHARACTERISTICS OF THE V. P. I. ARGONAUT RECTOR

E. Stam and A. Robeson; *Virginia Polytechnic Institute*

6. Since the V. P. I. Argonaut Reactor achieved first criticality in December 1959, a series of experiments has been underway to establish performance characteristics of the installation. A description of the reactor facility and results of some of the experiments are discussed. Critical mass, reactivity, control rod calibrations, power and shield performance characteristics are included.

A METHOD OF TRANSFORMING CONCENTRATED SURFACE FORCES INTO CONTINUOUS SURFACE FORCES

William Zuk and M. A. Majeed; *University of Virginia*

7. In such fields of mechanics as strength of materials, elasticity and vibrations, concentrated forces are often encountered. Because such concentrated forces represent mathematical discontinuities, the generalized analysis of such forces often presents difficulties. It is found that the use of Cauchy's Distribution Curve

$$\frac{P}{s\pi} \frac{1}{1+\left(\frac{x-a}{s}\right)^2} \quad \text{as} \quad s \to 0$$

to represent the concentrated force P lends itself well to simple analysis as the force may thus be treated as a continuous function in "x." Several examples of beams with various end supports and load arrangements are described, giving the results for shears, moments, and deflections expressed in single closed form expressions, valid for any region of the beams.

On the Motion of a Particle in a Free Vortex Centrifuge

John E. Scott, Jr.; *University of Virginia*

8. Consideration is given to the problem of classification of sub-sieve sized solid particles in a centrifuge in which a free vortex is maintained. The theory of operation of the centrifuge is discussed in terms of practical applications of the device. A non-ideal particle injection scheme, dictated by practical considerations, produces a deleterious effect on the performance of the classifier. Analysis of this effect leads to an ordinary, second-order, nonlinear differential equation, similar to the Fowler-Emden differential equation, which describes the radial motion of the particles in the centrifuge. Typical solutions of the differential equation, obtained from an analog computer, are presented; and the properties of the solutions are discussed.

The Analog Computer in Engineering Analysis

J. P. Raney; *University of Virginia*

9. This paper deals briefly with a few practical applications of the electronic analog computer to engineering problems. The problems considered are: (1) The solution of the equation of motion of a particle in a free vortex centrifuge. (2) The effectiveness of a catalyst pellet in a second-order reaction. (3) The solution for forced transverse vibrations of a beam with all non-homogeneous boundary conditions when vibrating at freqeuncies well above the fundamental or first natural frequency of the beam. Problems 1 and 2 above are ordinary second-

order non-linear differential equations but require different techniques of solution; a trial and error solution is used on 2 while a direct solution is possible with 1. The solution to Problem 3 is finessed by knowing the general mathematical form of the solution at the outset which is in the form of normal modes of vibration and amplitudes of these normal modes. The beam is broken into three parts consisting of a long center section and two short end pieces to which the constraining springs and dampers are attached. By generation of the normal modes and then properly closing the computer loop on the equations of motion of the end pieces the solution is obtained.

AN ANALOG STUDY OF THE STABILITY OF FLEXIBLE MISSILES WITH AUTOPILOT AND SECON-ORDER CONTROL RESPONSE

James B. Eades, Jr. and G. L. Smith; *Virginia Polytechnic Institute*

10. The flexibility of high-performance rocket vehicles is known to affect the stability of the system due to the bending, pitching, and control dynamics. Guidance and control systems respond to angular deflections in bending; and, under adverse conditions, structural feed-back into the control loop may lead to an instability. In this paper the structural feed-back problem is formulated in a simplified form, considering excitation of the structure in bending due to side control force. The governing differential equations for the system are derived; these lead to a sixth degree polynomial characteristic equation. To facilitate the study of this problem, the system is programmed on an analog computer with typical values of the variables assumed. In this manner a parametric study is conducted from which some simple relations are observed. An analysis of the results shows that the phase relations are of extreme importance in the stability of the bending modes. The computer results are applied to a typical missile; the variation of the different modes is plotted as a function of sensor location, all other factors assumed constant.

ON THE SIMULATION OF THE ELECTRON CONCENTRATION ENCOUNTERED BY A BODY DURING RE-ENTRY TO THE EARTH'S ATMOSPHERE

John N. Perkins and A. J. Russo, Jr.; *Virginia Polytechnic Institute*

11. The purpose of this paper is to describe the idea of using a combustion yet as a means for producing a plasma stream with electrical properties similar to those encountered by a hypervelocity vehicle upon re-entering the earth's atmosphere. The problem of radio wave attenuation is described also since the combustion jet apparatus has particular application to the study of this phenomenon. The combustion jet uses cyanogen (C_2N_2 and oxygen (O_2) as reactants. The resulting

flame produces the highest chemically obtained temperature known to man (4,850 °K at atmospheric pressure). Potassium, an easily ionized material, is injected into the flame where it ionizes, and the resulting electron concentration is found to be large enough to simulate even the most extreme flight conditions encountered by a re-entry vehicle. Theoretical calculations of the electron concentrations behind the normal portion of the shock wave in actual flight are presented and are compared with the electron concentrations obtainable from the combustion jet laboratory apparatus.

PROPULSION SYSTEM REQUIREMENTS OF THE MANNED INTERPLANETARY VEHICLE

R. W. Truit and P. R. Kurzhals; *Virginia Polytechnic Institute*

12. The parameters influencing a vehicle trajectory in free space are used in a relatively simple analysis for deriving the equations of motion of a space vehicle. Cylindrical coordinates are used to define the vehicle and planet positions; and planetary orbits are represented by ellipses for which initial characteristics may be obtained from any ephemeris. Propulsion and radiation-pressure forces are expressed as functions of the initial inclination of the thrust vector to the flight path. These forces can be varied to allow an accurate simulation of impulsive or continuous propulsion systems during a specific flight. Gravitational forces for the sun and n planets are derived in terms of the radius vector between the vehicle and the attracting body, and the resulting equations of motion may be readily expanded to allow the inclusion of effects of planetary satellites, such as the moon. Because of the complexity of an n body problem of this type, an exact analytical solution is not feasible, and an IBM 650 Computer was used to solve the equations of motion by a fourth-order Runge-Kutta integration procedure.

SPACE CABIN REQUIREMENTS OF THE MANNED INTERPLANETARY VEHICLE

R. W. Truitt and P. R. Kurzhals; *Virginia Polytechnic Institute*

13. The requirements of a manned interplanetary vehicle are discussed, and the literature of space medicine and environment are summarized to isolate the physical parameters affecting man's survival in space. The basic requirements of manned space vehicles on prolonged trips are defined, and optimum solutions to some of the related problems are proposed. To illustrate typical values to be expected in later development, the preliminary characteristics of a space cabin suitable for a trip to Mars and return are then derived. A regenerative life support system capable of sustaining a crew of five for a thousand day journey is outlined, and a weight and volume breakdown of this system, along with

the auxiliary equipment required by such a space vehicle, is included. The final vehicle weight is compared with the weight of a similar vehicle carrying stored food, water, and oxygen.

A STUDY OF THE CONDITIONS WHICH CAUSE THE PITTING OF INCONEL AND INCOLOY DURING PICKLING

W. A. Wilkinson, J. A. Miller, and N. F. Murphy;
Virginia Polytechnic Institute

14. The pitting, while pickling, of Inconel and Incoloy was studied by varying the concentration of the pickling solution, temperature, and time of immersion. The concentrations of pickling solutions of nitric and hydrofluoric acid were varied from 29.06 and 5.66 to 35.87 and 3.41 weight per cent, respectively. Five chloride ion concentrations of 0 to 4.0 weight per cent were studied in each of the pickling concentrations. Specimen immersion times from 15 to 90 minutese and solution temperatures from 21° to 43°C were used. The investigation was designed statistically by using a fractional factorial with a one-fifth replication which permitted the study of second level interaction of the variables. The data were analyzed using an IBM 650 computer. The weight loss of Inconel and Incoloy increased with increasing hydrofluoric acid, chloride concentrations, time, and temperature. An interaction, chloride and temperature, was found to exist for Inconel. At lowest temperature weight loss decreases; at the highest temperature weight loss increases with increasing chloride concentration. No such interaction exists for Incoloy, but pitting increases with increasing chloride ion concentration.

A prediction equation relating the variables studied will be formulated.

NEUTRON FLUX MEASUREMENTS BY THIN GOLD FOILS

Arthur P. Deverill; *University of Virginia*

15. The induced bet activity in thin gold foils is used to measure neutron flux. Determination of the beta activity of the foil requires a knowledge of the following factors: foil's self-absorption; back scatter of the foil support; absorption in air (and window) of the detector; and, contributions from radiations other than betas resulting in the decay of the gold nucleus. Gold is evaporated onto plastic, irradiated in a Graphite Pile and counted in a 2π Low Background Detector. The above factors are optimized in the following manner: Foil self-absorption is minimized by using very thin gold films. The plastic substrate has negligible back scatter. The absorption in air is minimized by geometry, and absorption in window is low because of the thin mylar window of the detector. The contribution of gamma rays is minimized by the low efficiency of the detector to gamma radiation. The disintegration rate

of an activated gold film, which is proportional to the thermal neutron flux, can be determined from the observed activity.

NEUTRON FLUX MEASUREMENTS WITH A HYDRAULIC RABBIT

George H. Gardes and George A. Custer; *University of Virginia*

16. There are three reasons for determining the neutron flux in a swimming pool reactor: thermal flux is an indication of power level; flux levels are needed for irradiation experiments; fast flux indicates the amount of radioactive nitrogen in the water. A common method of measuring flux is with gold foils. The neutron flux in the University of Virginia Reactor will be measured by an aluminum slug system, driven by water pressure. The system is 22 feet long, allowing measurements to be made from the bridge across the pool. The system has 3/16″ aluminum tubing in order to place the slugs between the fuel plates. The rabbit is the aluminum slug, and will be run both bare and Cd covered in order to obtain thermal and fast neutron flux. Aluminum has a low absorption cross section but the flux level will be high enough to secure an acceptable activity. After exposure in the core, the slug will be driven to the bridge and immediately counted for activity. The 2.3 minute half life activity will indicate the thermal flux level of the core at the measurement position. Many repetitions of this procedure will produce a flux plot of the core.

DESIGN FACTORS OF A NITROGEN ISOTOPE CHEMIQAL EXCHANGE TOWER

C. A. Renfroe, D. A. Hayford and F. W. Bull; *Virginia Polytechnic Institute*

17. A study of the design aspects of a chemical exchange tower for the separation of nitrogen-15 and -14 was completed. The isotope exchange reaction proceeded by countercurrent contact of nitric acid and nitrogen oxides gas. An oxide reflux reactor was used to convert the nitri cacid to nitrogen oxides by reaction with sulfur dioxide. A recovery tower was used to convert the nitrogen oxides to nitric acid by oxidation of the nitric oxide followed by absorption of the nitrogen dioxide in water. Verification of the third order mechanism for the oxidation of nitric oxide was affected. The effect of nitric acid strength in the reactor on the ratio of nitric oxide to nitrogen dioxide fed to the exchange tower was determined. Pressure drop data for the exchange tower were correlated with the chemical tests to yield operating limits of the exchange unit. Using an enrichment factor of 1.05 and the experimental operating limits, the following design criteria were evaluated: (1) the effect of retention time on the approach to steady state; (2) the effect of stage length on the approach to steady state; and (3) the interrelation of production rate, stage length and product composition a steady state.

HEAT TRANSFER AND PRESSURE DROP PERFORMANCE OF A BAFFLED HEAT EXCHANGER IN COOLING A PETROLEUM OIL

Fred W. Bull and Patrick H. DeHart, Jr.; *Virginia Polytechnic Institute*

18. This investigation was to study the effect of baffle design and spacing on the heat transfer and pressure-drop characteristics of a double-pipe, countercurrent heat exchanger in cooling a petroleum oil in streamline flow. Visual flow studies were conducted on six disc baffles, one spiral wire baffle and one spiral strip baffle, the baffles being installed in a three-quarter inch diameter, pyrex glass pipe. A dye was injected into the oil stream 58 inches upstream from the battle, and the flow patterns around the baffle were observed visually and were photographed with a Speed Graphic camera using a shutter speed of 1/400 sec and a lens opening of f-4.7. Each baffle was evaluated by the length and width of disturbance imposed upon the oil stream. The spiral wire and spiral strip baffles exhibited the most effective visual performance, the disc baffles imposing no effective disturbance in the oil stream. Heat transfer and pressure-drop studies are now being conducted to evaluate the operational performance of each baffle.

ANOMALIES IN THE OPERATION OF OVEN-TYPE MOLECULAR BEAM SOURCES

Ricardo Zapata and John E. Scott, Jr.; *University of Virginia*

19. A discussion of the nature of flow in molecular beam sources is presented. Defining λ as the molecular mean free path in the source chamber and d as the diameter of the source orifice, free molecule flow is characterized by $\lambda >> d$ and hydrodynamic flow by $\lambda << d$. For the case of molecular effusion the spatial distribution is given by the cosine law, and no intermolecular collisions occur. For the case of hydrodynamic flow, main motion is more pronounced in the axial direction than given by the cosine law, and the frequency of intermolecular collisions is relatively large. Experiments in both flow regimes are discussed. Results indicate that higher beam intensities are obtained by using a conical channel in the source chamber. Beam attenuation rates, due to collisions of beam molecules with background molecules in the collimating chamber, are also studied. It is found that the attenuation becomes significant when the collimating chamber pressure rises above 10^{-4} mm Hg. Total beam intensities of about 7×10^{13} molecules/sec have been obtained with nitrogen at room temperature. Improved pumping in the collimating chamber and optimum source design could increase this figure by an order of magnitude.

THE GENERATION OF MOLECULAR BEAMS FROM SHOCK TUBE SOURCES

Arthur C. Bruce; *Virginia Polytechnic Institute*

20. In the present day field of aerodynamics a problem of major interest is the simulation in the laboratory of high speed, high altitude vehicle flight. The present paper considers several aspects of generating a free molecule flow in the form of a molecular beam from a source consisting of a conventional shock tube. The results of performance calculations for a given shock tube utilizing a helium/air combination of driver/driven gases are presented in the form of ratios of pressure and temperature in the source to initial conditions before firing of the tube. The flow regime utilized in the tube for a beam source is that flow existing for a short duration at the end of the tube immediately after shock reflection from the tube end and previous to arrival of the contact surface at the tube end. It is shown that effusive flow requirements restrict the beam aperature size and beam intensity to a large extent, which combined with short steady source time necessitate a high sensitivity, fast response system of instrumentation.

NON-EQUILIBRIUM MOLECULAR DISSOCIATION OF AIR IN A HYPERSONIC NOZZLE

John N. Perkins; *Virginia Polytechnic Institute*

21. The equations of motion for the flow of dissociating air in non-equilibrium through a nearly conical nozzle have been developed. By treating the air as a mixture of two ideal dissociating gases, oxygen and nitrogen, the equilibrium solution is obtained. Assuming a simplified form of the rate equation, the equilibrium solution is extended to the case where equilibrium is not achieved everywhere in the flow. The results of the investigation suggest that deviations from dissociation equilibrium will ocurr in the nozzle, but that the so-called phenomenon of "freezing" will not occur as generally predicted for single diatomic gases.

AN OPTIMIZATION STUDY ON LOW THRUST ROCKET PARAMETERS

James B. Eades, Jr.; *Virginia Polytechnic Institute*

22. A study on the influence of several design parameters for low thrust rockets is carried out to ascertain the relation between these parameters for optimal considerations. Due to the dependency of these parameters on one another, a simplified anlysis is set forth which shows the influence of a programmed trajectory on the final weight, velocity gain and payload. For a maximum payload, the influence of the optimal path thrust and/or power on payload is defined. In addition the attained velocity and the exhaust velocity are described for a specified average of the optimum conditions.

ON A SOLUTION TO THE UNSTEADY LAMINAR BOUNDARY LAYER

H. A. Hassan; *Virginia Polytechnic Institute*

23. It is shown that the transformation $\xi = x/\sqrt{2\,\nu\,t}$, $\eta = y/\sqrt{2\,\nu t}$ reduces the unsteady laminar boundary layer equations in two dimensions to an equation in which "t" does not appear exlicity provided that the free stream velocity $V(x, t)$ can be expressed as $(\sqrt{\nu/2\,t})\ h\ (\xi)$. A power series solution is assumed for the resulting equation, and it is shown that for $h = \xi^{\alpha} \sum_{n=0}^{\infty} a_n\, \xi^n$ (α an integer) the solution can be expressed in terms of universal functions. For all values of α, the zeroth term of the assumed series, which is chosen to satisfy the outer boundary condition exactly, is governed by known equations.

QUANTUM MECHANICAL ASPECTS OF THE THERMODYNAMIC PROPERTIES OF GASES

Robert W. Truitt; *Virginia Polytechnic Institute*

24. The chemical equilibrium composition of a hydrogen plasma is determined over the temperature range from 10^3 °K to 10^6 °K and pressures from 10^{-6} to 1 atmospheres. The solution of the equations is simplified by considering the problem in two steps: the first in the temperature range where dissociation occurs and the second in which only ionization occurs. The general method of attack is outlined which is applicable to the equilibrium solution of any plasma. Particular attention is given to the formulation of the partition functions and to the quantum mechanical aspects of the thermodynamic properties of the plasma. Equilibrium and frozen values of the ratio of specific heats and the speed of sound are presented in the complete dissociation and ionization regimes. Some interesting thermodynamic property changes that occur during dissociation and ionization are discussed relative to application to high-speed aerodynamic analysis.

AN ENGINEERING STUDY OF A ROTARY DRUM CRYSTALLIZER

John C. Chaty; *University of Virginia*

25. The rotary drum crystallizer is a purification device which incorporates the principles of zone melting and conventional fractional crystallization for the recovery of organic or inorganic solute of high purity from the solvent. In the rotary drum crystallizer, solids are deposited from the molten liquid on the cooled surface of a drum, are carried from the melt by rotation of the drum, and then removed and conveyed

to another crystallization stage. While this crystallization device is not a true zone refiner which involves the traveling of a small molten zone through a long solid charge with redistribution of the solute in the charge, neither is it a conventional fractional crystallizer where solids are formed and removed as fine crystals. It is believed that this device has great advantages in heat and mass-transfer effectiveness and in ease of mechanical separation. In a single stage laboratory scale rotary drum crystllizer the process variables, such as, the temperature difference between the melt and the drum surface, the rate of drum rotation, and the depth of immersion are studied. Preliminary results show that from a melt of 95% naphthalene-5% benzoic acid a product of 99.5% naphthalene is obtained under favorable conditions.

THE DETERMINATION OF HEAT TRANSFER CHARACTERISTICS FOR A MOVING BED SYSTEM COMPOSED OF AIR AND ACTIVATED CARBON

W. A. Barkley and Stuart B. Row; *Virginia Polytechnic Institute*

26. Heat transfer characteristics for moving particles of carbon in an air atmosphere were studied. A single pass, co-current heat exchanger 36 inches long was constructed using 3/4-inch and 2 1/2-inch schedule 40 black iron pipe as the tube and shell, respectively. Steam was used as the heating medium. Three variables, steam pressure, carbon flow rate, and carbon particle size, were evaluated in the investigation. Steam presure was varied from 15 to 75 psig, at 15 psig increments; carbon flow rate was varied from 2.2 to 11.0 lb/hr, at 2.2 lb/hr increments; and carbon meshes of 10, 14, 20, 28 and fines were tested. Thirty tests were made to approximate the results of a complete evaluation (125 tests). An equation relating the overall heat transfer coefficient with the three variables has not yet been completed, but the following trends for the overall heat transfer coefficient, U indicated: (1) U increased as the carbon flow rate increased; (2) U increased as the carbon particle size increased; and (3) U remained approximately constant with changes in steam pressure. Calculated values for U varied from 1.58 to 4.02 Btu/hr-ft.^{2}–°F. A straight line temperature profile through the heat exchanger indicated a varying carbon film coefficient.

THE USE OF HIGH ROTATIONAL SPEED EQUIPMENT TO COMPLEMENT MOLECULAR BEAM STUDIES IN GAS DYNAMICS

Hubert J. Davis, Jr.; *University of Virginia*

27. The production of molecular beams at the University of Virginia Research Laboratory for the Engineering Sciences has made it desirable to design and construct a device to experimentally determine the distribution of vlocities in molecular beams. The currently accepted method of

accomplishing this purpose is by use of a device consisting of a rigid shaft separating two circular discs. Around the periphery of the discs are cut narrow radial slots. With proper design, this particular configuration, when placed in a molecular beam, will allow molecules only within a small velocity range to pass through the selector. Analysis shows that a device of entirely different configuration should produce the same results. This latter type of selector consists of a thin circular ring in which narrow slots are cut in a direction perpendicular to the radii of the ring. The ring selector has the inherent advantage of being readily adaptable to techniques of magnetic suspension. However, a detailed analysis shows that even with careful selection of design parameters, structural limitations prohit a ring selector design consistent with the performance necessary for use in molecular beam studies.

THE ANALYSIS OF ION BEAMS USING A RADIO FREQUENCY MASS SPECTROMETER

Hugh S. Landes; *University of Virginia*

28. An r-f mass spectrometer for analyzing low energy ion beams was built. The unit is a miniature modification of a design by Paul, et. al. It employs the mass dependence of a strong-focusing electric quadropole field for the filtering of different masses. A spectrometer operating on this principle is a pure mass filter in the sense that neither energy selection nor momentum selection is required; ions are selected solely on the basis of mass. The field structure, measuring 8 cm in diameter by 26 cm in length, is portable and can be placed in a vacuum system. The apparatus is capable of measuring ions of mass numbers ranging from 1 to 140 with a resolution up to 150. The spectrometer has been used successfully to analyze a molecular beam of nitrogen ions for impurity content. Intensities as low as 1 part in 1000 were measured. In addition to the determination of beam purity content, the spectrometer will be used to identify particles before and after collisions. The small size and convenience of handling, coupled with ability to select a particular mass, regardless of energy, makes the r-f spectrometer a valuable device in the research of low energy molecular beams.

HIGH SPEED DRAG ON ROTATING CYLINDERS AT LOW PRESSURES

J. H. Bodine; *University of Virginia*

29. Consider a gas between two infinitely long concentric clyinders of radius a and b $(b > a)$, the inner cylinder rotating with a peripherial velocity V. Assume the density of the gas sufficiently low so that a negligible number of molecular collisions occur in the annular space, the

molecules moving from surface to surface in straight lines. Also assume the gas molecules leave each surface with a Maxwellian distribution of velocities with respect to a coordinate system fixed onto that surface corresponding to a common temperature. The velocity distribution in a non-rotating coordinate system of the molecules leaving the inner cylinder will be skewed by rotation, resulting in the pressure in the annular region being a vector quantity. Define $Q \equiv a/b$, S as the ratio of V to the most probably velocity of the molecules leaving the surface, and p_y as the pressure measured perpendicular to a radius at the outer cylinder surface. A detailed analysis shows the torque per unit length will be:

$$a\sqrt{x}\ p_y a^2 s/G\ (Q, S)$$

The function G(Q, S) will be defined and numerical values of it presented. Generally: (1) $G(Q, S) \geq 1$; (2) G(Q, S) is monotonically increasing in S; (3) G(Q, S) is a maximum for a Q of about 0.65.

A TECHNIQUE FOR MEASURING CAPACITY CHANGES OF TWO INSULATED HEMISPHERES

B. J. Gilpin and R. R. Humphris; *University of Virginia*

30. In this paper, the total capacity between two insulated hemispheres is considered as being composed of a direct capacity and a mutual capacity. The direct capacity is defined as the "free space" capacity between the two hemispheres. The mutual capacity is defined as the series combination of the two capacities between each hemisphere and ground. An experimental technique is described for determining the variations in the total and the component capacities as a function of: (1) the distance above a conducting grounded plane; (2) the diameter of the sphere, and (3) the separation of the hemispheres. A size factor is determined so that the results of measurements made on specific spheres may be extended to other sizes. The changes in the total capacity which occurred between the two halves of the sphere as they approached ground were detected by a neon tube oscillator built into the sphere in such a manner that the total capacity between the hemispheres was one of the frequency-determining components of the circuit. The neon tube was mounted in a flashlight reflector, and a Fresnel lens was used to focus the light onto a phototube. The output of the phototube was amplified and the frequency determined by a Hewlett-Packard, Model 524B, electronic counter.

A PROXIMITY PICKUP WITH A VACUUM TIGHT PROBE

W. M. Bland and W. H. Dancy, Jr.; *University of Virginia*

31. Displacement measurements of metallic objects which are vibrating at high speeds are possible using a non-contacting probe and read-out

system. A tuned grid-tuned plate r-f oscillator coupled to an infinite impedance detector was used in the system. Any voltmeter, oscilloscope, or recorder may be used to read-out the displacement. The grid coil of the oscillator was physically separated from the remainder of the circuit and was connected electrically through coaxial cable. This grid coil acted as a proximity pickup due to the loading effect produced when metallic objects were placed in the r-f field produced by it. To facilitate measurements in both pressure and vacuum environments, the grid coil was mounted on the end of a sylphon bellows sealed, micrometer slide apparatus which may be inserted into the environmental chamber through a standard "veeco" vacuum seal. The micrometer slide permitted calibration and adjustments in position, while the apparatus was operating. By operating the oscillator at a frequency of 6 mc, one obtained an output signa lof 2 volts per 0.001" of displacement, linear over $\pm$ 15 thousandths of an inch. This output signal followed displacements which occur at rates up to 100 kc.

PREPARATION OF PLATED SPECIMENS FOR MICROSCOPIC EXAMINATION OF CHROME-STEEL INTERFACE

J. B. Fracis and W. H. Dancy, Jr.; *University of Virginia*

32. A method of polishing was developed which permitted a highly magnified examination of the interface of chrome plated steel sepcimens. The specimen was prepared by grinding on a series of emery papers of decreasing grit size. It was polished for two minutes on a polishing table covered with "Fisher No. 12-284" polishing cloth, using "Gamal" (gamma alumina) as polishing compound. The sample was then gently polished on a No. 0000 emery polishing paper for two minutes. The alternate grinding and polishing operations were repeated at least three times. The specimen was then etched for 20 sconds in a 50% by volume solution of hydrochloric acid and water maintained at room temperature. Since chromium is etch at a higher rate than steel, this treatment leaves the surface of the chromium lower than that of the steel. Final polishing removed the excess steel and leaves the chromium surface highly polished and level with the steel. A final 15 second etch in a solution of ethyl alcohol containing one drop of concentrated nitric acid per cc darkened the steel surface and gave sufficient contrast between chromium and steel to allow detailed boundary examination at high magnifications.

SATELLITE ORIENTATION USING MAGNETIC SUPPORT METHODS

R. E. Russell and O. R. Harris; *University of Virginia*

33. The usefulness of an earth satellite as an experimental device would

be greatly enhanced if it could be spatially oriented in a controllable manner while in orbit. Three flywheels mounted orthogonally within the satellite and rotated by electric motors should provide the desired attitude control of the satellite. However, the frictional loss in angular momentum of the fly-wheels will result in undesired rotations of the satellite. One method of eliminating the mechanical bearing friction is the electromagnetic support technique developed by J. S. Beams of the University of Virginia. The proposed system consists of a three-dimensionally supported ferrite or sphere and a drive system to rotate the sphere in the desired direction. Preliminary calculations were made assuming what was considered to be a "worst case" orientation problem. For a ferrite sphere with a rotational hysteresis loss constant of 150 dyne-cm/cm^3, the sphere radius was found to be about 10 cm. and the required peak driving power is 122 watts. Additional work is now being done on the use of conducting spheres; estimates are being made of the torque interaction between the support field and the rotating sphere.

THE SOAKING EFFECT — APPARENT DRAG REDUCTION ON BODIES HELD AT LOW PRESSURES FOR EXTENDED PERIODS OF TIME

J. E. May and A. R. Kuhlthau; *University of Virginia*

34. In using a concentric cylinder apparatus for the determination of drag in gases at low pressures it was observed that drag apparently decreases when the apparatus is allowed to stand at low pressures for several days. This has been called the soaking effect. In the present experiments the effect was studied over a month wider range of variables than heretofore. The results of this study, are not yet conclusive, but suggestions for further rather crucial experiments were obtained.

A STRENGTH CRITERION FOR COMPACTED FINE-GRAINED SOILS

H. G. Larew; *University of Virginia*

35. Two strength criteria for the failure of compacted fine-grained soils under the action of repeated loads were postulated and experiments to investigate these were initiated on three soils: a micaceous silt, a limestone residual clay, and a sand-clay. Conventional and repeated stress triaxial strength tests were employed to study and compare the strength and deformation characteristics of identical specimens of each soil which had been carefully prepared by a static compaction process. For the soils studied and the test conditons employed, a criterion of failure has been established as follows: a critical level of repeated deviator stress exists at which the slope of the curve of deformation versus number of repetitions is constant after the first few load applications. For levels of deviator stress in excess of this critical value, the deformation curves

eventually turn concave upward, their slopes increase and the soil fails either in shear or by excessive deformation. For levels of deviator stress less than the critical value, the deformation curves eventually approach a horizontal asymptote.

ROTATIONAL HYSTERESIS LOSSES IN NICKEL-ZINC FERRITES AT LOW FREQUENCIES

R. Berner and H. S. Landes; *University of Virginia*

36. Measurement of rotational hysteresis losses of small ferrite spheres at low frequencies were made. Rotational hysteresis torque arises from an interaction between the magnetization and the crystal structure, but very little is actually known about the interaction mechanism involved. It is known, however, that since there is a coupling between magnetization and crystal structure, a rotation of the mangetization in the body will produce a torque on the body itself. It would appear that this effect might be useful in torquing a magnetically supported rotor. For this, ferrite compositions of high torque densities might be used, or the ferrites could be used as rotors for a magnetically supported free gyroscope, in which case, a redutcion of rotational loss is of interest. Ferrites belong to a group of non-conducting magnetic materials with low or high rotational losses depending primarily on composition. A torsional pendulum apparatus was used for the measurements. A clear trend toward zero rotational hysteresis losses was obtained in a group of nickel-zinc ferrites by varying composition.

MAGNETOSTRICTION IN Ni — Zn FERRITES

G. S. Nurre and H. S. Landes; *University of Virginia*

37. As part of a ferrite research program, a device for measuring magnetostriction was built and measurements were taken for several ferrites. Since the magnetostriction coefficient (λ) for these ferrites is of the order of 10^{-6} cm/cm, for a one cm diameter sphere, dimensional changes of 10^{-6} cm must be measured. An ultramicrometer, consisting of a differential capacitor, was designed with satisfactory sensitivity. The device was calibrated by measuring the calculated deflection of a small doubly supported steel beam, and was found to be linear with a sensitivity of 3.73 x 10^{-6} cm per millivolt. Measurements were made of λ as a function of applied field for a series of Ni — Zn ferrite and for a Co — Zn ferrite. The magnetostriction curves are compared to the magnetization curves, and the comparison is especially interesting for the Co — Zn ferrite, which exhibits a change of sign in the magnetostriction curve. For the ferrite series, $Ni_\gamma Zn_{1-\gamma} Fe1.95$, λ_s is ploted as a function of γ. The data indicate that λ_s is linearly dependent on γ and is zero for $\gamma = .225$. The

position of the zero point is as expected, since the Curie temperature for $N_{0.225}$ $Zn_{0.775}$ $Fe_{1.95}$ is very close to room temperature.

SECTION OF GEOLOGY

MINERAL PARAGENESIS IN THE MYERS-L. COPENHAVER BARITE MINES SMYTH COUNTY, VIRGINIA

Donald K. Grubbs and Robert C. Barnes; *University of Virginia*

1. This paper is concerned with the Myers-L. Copenhaver mines, which are situated four miles west of Marion, in Smyth County, Virginia. Its two-fold purpose is to report a new occurrence of sphalerite in Virginia, and to interpret the sequence of mineral deposition at the deposit in which it occurs. The barite and gangue minerals occur as fracture fillings within brecciated Beekmantown limestone of Ordovician age. The fractures are irregular in pattern and are filled with hydrothermal minerals which were deposited at very low temperatures — as evidenced by the complete lack of alteration in the wall rock. The minerals in the general order of deposition are pyrite, sphalerite, limited purple fluorite, barite, clear fluorite, and calcite. The pyrite occurs in thin, fine-grained bands lying adjacent to the wall rock in most cases. Honey colored sphalerite generally follows the pyrite. A small amount of deep purple fluorite appeared to have been deposited before the barite crystallized. The next mineral in the sequence is the radiating, tabular, or prismatic barite. Clear fluorite follows it, and is usually succeeded by white calcite. Considerable overlapping occurred, particularly among the last three minerals.

RETENTION OF KCl BY HALLOYSITE

G. W. Thomas; *Virginia Polytechnic Institute*

2. The retention of KCl by hydrated and dehydrated halloysite was studied, using clays from Floyd and from Piney River, Virginia. Washing solutions used were 95 percent ethanol, 100 percent methanol and distilled water. Ethanol removed KCl ineffectively from hydrated halloysite. About eight washings were required with methanol to remove the bulk of the salts, while water cleaned the hydrated clay rather completely in three washings. Dehydrated clays were washed effectively by both methanol and water while ethanol was somewhat less effective. X-ray data showed that the KCl was held between layers of hydrated halloysite, suggesting that drying before KCl-saturating destroyed the salt-holding site.

COMMENTS ON APATITE FROM THE MOREFIELD MINE, AMELIA COUNTY VIRGINIA

E. H. McGavock and R. S. Mitchell; *University of Virginia*

3. Apatite grains and crystals, ranging from less than 1 mm to over 5 mm across occur in cleavelandite and quartz at Morefield Mine, Amelia County, Virginia. The material is light gray, white or pale aqua-green in color, with stubby crystals consisting of pinacoids and first and second order hexagonal prisms. Goniometric studies showed the presence of 11 forms on one crystal. Indistinct cleavage occurs parallel to $(10\bar{1}0)$ and (0001). X-ray powder data compare favorably with typical fluorapatite patterns. The apatite fluoresces a bright orange-yellow in both long- and short-wave ultraviolet radiation. In unfiltered copper x-rays, the mineral fluoresces a bright yellow. No phosphorescence was observed as a result o fultraviolet radiation, but x-rays produced a persistent yellow phosphorescence. Strong orange-yellow thermoluminescence occurs when the apatite is heated in a Bunsen burner flame in the dark. Most apatite is not fluorescent. A semiquantitative spectrographic analysis was made to determine impurity elements which might activate the fluorescence. Trace elements (oxides) made up about 7% of the mineral's composition, of which, about 1% was rare-earths (chiefly cerium and yttrium), 2.5% silicon, and 2% manganese. Manganese produces a bright yellow fluorescence in some phosphates. Comparison of Morefield apatite analyses with published aanlyses of rare-earth apatites from Mineville, N. Y., showed that the chief difference was the high manganese content in the Morefield material. The Mineville apatite is not fluorescent, thus it seems that the activating element is manganese.

GEOLOGY OF THE LEXINGTON QUADRANGLE, VIRGINIA

Kenneth F. Bick; *Washington and Lee University*

4. The Lexington quadrangle, Virginia, includes parts of the Blue Ridge and the Valley and Ridge province of the Appalachian Highlands. The range in age from Precambrian to Middle Deevonian. The Precambrian igneous and metamorphic basement complex is unconformably overlain by 2500 feet of clastic and volcanic rocks of Precambrian and Early Cambrian age. These rocks represent westward transgression of a sea across the area. The clastic rocks are overlain by 10,000 feet of Early Cambrian to Middle Ordovician rocks, chiefly carbonates, that represent a long period of shallow water, offshore deposition. The carbonate sequence is overlain by about 5000 feet of Middle Ordovician to Middle Devonian clastic rocks that represent the debris eroded from land areas east of the quadrangle. The rocks were deformed during the Appalachian orogeny. There are 3 structural units: the Blue Ridge, the

Central, and the Northwestern belts. The Blue Ridge belt is characterized by folding and faulting of the Precambrian basement complex; it is bounded on the northwest by the previously unmapped South River fault. The Central belt is characterized by low angle thrust faulting of the sedimentary rocks. The Pulaski fault branches southwest of Fairfield and the west (main) branch is continuous with the Staunton fault. The minor east branch, earlier considered to be the main Pulaski fault, is named the Fairfield fault. A complex area near Brownsburg is a window in the North Mountain fault and this fault is also complicated by three branches northwest of Brownsburg. The center branch is the main fault. The Northwestern belt is characterized by folding of the sedimentary rocks. One thrust fault of minor displacement bounds a large overturned anticline in the northern part of the belt. The deformation appears to proceed from folding of sedimentary rocks to thrust faulting of sedimentary rocks and finally to thrust faulting of the competent basement complex over the other structures. (*Published by permission of the State Geologist, Virginia Division of Mineral Resources.)

A DIABASE DIKE NEAR GREENVILLE, AUGUSTA COUNTY, VIRGINIA

Frank Howard Campbell, III and John Milton Cole, Jr.;
University of Virginia

5. A diabase dike ranging in width from 35 to 50 feet was traced from Avis to the C. T. Glover farm on Virginia Secondary highway 695, 0.8 mile south of Arbor Hill, for a total length of 5.5 miles. This intrusive crosses U. S. 11 approximately 3.3 miles north of Greenville, southern Augusta County, Virginia. The dike transects strata ranging from the upper Cambrian Elbrook dolomite to the upper Ordovician Martinsburg shale. The dike which trends from N 10 W to N 25 W crosses the Massanutten syncline near its southwestern terminus. Roughly 0.1 mile east of the confluence of Virginia Secondary 697 with 693 the dike crosses the Staunton Fault. According to T. L. Watson and R. W. Johnson, Jr. this and many other dikes in the region closely parallel a known major joint direction of the Appalachians. Thus we conclude that the emplacement of this intrusion was joint-controlled. Microscopically, this olivine diabase contains abundant calcic labradorite, twinned according to the albite and carlsbad laws. Considerable augite surrounds the plagioclase to form a well-developed ophitic texture. Olivine is third in importance and an estimated 3 to 4 per cent is present. Although aeromagnetic surveys by the U. S. G. S. have found that the diabases of the Valley show little or no magnetic expression, the calculated susceptibility of the rock is 10,200 cgs units. The extent and attitude of the dike was studied with a Schmidt balance vertical force magnetometer. Six traverses were run normal to the dike trend. These magnetic profiles having a maximum expression of

600 gammas. It is postulatd that other diabases of the Valley will give good expression to ground magnetic survey methods.

A PETROGRAPHIC STUDY OF SOME DIKES IN A QUARRY IN BLUEGRASS VALLEY, HIGHLAND COUNTY, VIRGINIA

E. K. Rader and V. S. Griffin; *University of Virginia*

6. The dikes under consideration were found in a quarry 2.5 miles north of the village of Hightown, Highland County, Virginia. One basic dike and four intermediate dikes were observed. An abundance of serpentine was noted in the basalt, possibly due to the post crystallization migration of the hydrothermal residual solutions of the andesite magma. The intermediate dikes have previously been classified as "felsophyre" and "granite-feldsophyre," but our petrographic work revealed that the name andesite porphyry would better describe this light-gray dike material, composed of plagioclase (basic oligoclase to acid andesine), biotite, hornblende, ilmenite, limonite, hematite, and leucoxene. These dikes appear to be controlled by jointing and two low to moderate angle reverse faults, which have caused brecciation giving rise to the carbonate pebbles in some of the andesite materials. It appears that the folding of the Hightown anticline and the jointing occurred first. Next, the basalt was injected into a NW trending joint in the Beekmantown limestone. Fially, the andesite was intruded along both joints and faults trending NE.

UNDERGRADUATE RESEARCH PARTICIPATION PROGRAM IN VPI DEPARTMENT OF GEOLOGICAL SCIENCES

Byron N. Cooper; *Virginia Polytechnic Institute*

7. The undergraduate research participation program carried on during the last six weeks of the summer of 1959 and during the fall and winter quarters of the 1959-60 academic year was sponsored by the National Science Foundation. Eight undergraduates were selected for the program, and each participant was assigned a limited research project. The six weeks during the summer, when field work was carried on, allowed time for gathering of field data. During the fall and winter months, the participants worked up their data, carried on laboratory studies, and drafted final reports on their studiese. The results are being presented before the Virginia Academy of Science in order to show that it is not only possible but quite feasible to launch students into limited research participation while they are still undergraduates. The studies, and drafted final reports on their studies. The results are knowledge of the geology of Virginia. Three of the studies uncovered types of field evidence that are of special and outstanding significance

to our understanding of the geology of the Appalachian Mountains. Considering the funds invested and the tangible accomplishments of the program, as indicated by the following papers, the undergraduate research participation program was very successful.

STRATIGRAPHY AND PETROGAPHY OF TWO SECTIONS OF NOLICHUCKY SHALE IN THE SOUTHWEST PART OF VIRGINIA

James W. Bryan; *Virginia Polytechnic Institute*

8. Two of the finest exposed sections of the Upper Cambrian Nolichucky shale are situated in Russell and Smyth Counties, Virginia. The unique lithology can be subdivided into three distinctive parts: an upper part consisting of banded limestones, dolomites, and fossiliferous calcarenites; a central part consisting of calcareous shales, dolomitic sandstones, and edgewise conglomerates with limestone and dolomite pebbles and a lower part consisting of banded limestones and dolomites. The Nolichucky is largely limestones and dolomites in Virginia and the usage of Nolichucky "shale" is somewhat misleading. Two hundred samples collected during the detailed litho-stratigraphic measurements were subjected to controlled acid tests and 90 were examined by x-ray studies. The yellowish-brown, sandy textured weathering or rusty weathering, characteristics of the Maynardville lithology, proved to have a varied mineralogy and were not indicative of dolomite as has generally been considered. Some sample of the rusty weathered material proved to be pure calcite. The megascopic appearance of the different beds can not always be correlated directly with the mineralogy of the beds. A potassic feldspar occurs with the carbonates as well as the other clastic beds.

POST-CANADIAN DISCONFORMITY AND THE RELATED MOSHEIM LIMESTONE NEAR CHATHAM HILL, VIRGINIA

Wilson Fisher, Jr.; *Virginia Polytechnic Institute*

9. The post-Canadian disconformity and the overlyin Mosheim limestone were mapped in detail in three areas near Chatham Hill, Smyth County, Virignia. The maximum relief of the surface of disconformity in the mapped areas is 160 feet, but "stray" detrital pieces of Knox chert in overlying beds as high as the Effna formation suggest that the local relief may have been as much as 400 feet. Vertical cliffs and overhangs in the Knox group are evident along the disconformity. The Mosheim limestone consists of a series of lenses which are thickest in old stream or river channels on the disconformity. The lenses of Mosheim limestone thin out against topographic "highs" of the erosional surface and some debris from these "highs" was transported into the lower

areas during deposition of the overlying Lenoir limestone. The basal part of the Mosheim consists of coarse clastic limestone containing interbedded chert breccias and dolomite conglomerates, with some detrital dolomite. The clastic rocks follow the disconformable surface and were deposited at different times in pockets of the Knox dolomite, as the basal portion of the Mosheim limestone. Numerous "veins" of relatively fine grained clastic material transect the bedding of the Mosheim and are composed of dolomitic sand and chert fragments from the Knox. These "veins" are generally at right angles to bedding and fill clefts or cavities left by fracturing and solution of the Mosheim immediately after consolidation.

AREAL GEOLOGY OF THE REGION JUST SOUTH OF SALTVILLE, VIRGINIA

Joel T. Blankenship; *Virginia Polytechnic Institute*

10. The abrupt southeastward deflection in the trace of the Saltville fault in the vicinity of Saltville, Smyth County, Virginia, poses an interesting problem: Is the deflection in the fault trace the consequence of a cross or tear fault that offsets the Saltville thrust, or is the offset merely the consequence of local flattening of the thrust surface, which causes the trace to follow a level-line course around the hills that rim Saltville on the east and south? Areal geologic mapping of the formations southeast of the fault trace of the Salville thrust shows no offset of any mappable units comprising the thrust block. The swing in outcrop pattern of the various mappable units in the Upper Cambrian and Lower Ordovician formations in the south and east environs of Saltville does not require any cross faulting, and none apparently exists. This interpretation means that immediately east of Saltville, the thrust surface is flat over a considerable area, which might make drift mining of salt a feasible undertaking.

CHEMICAL STRATIGRAPHY OF MIDDLE ORDOVICIAN LIMESTONES IN A PORTION OF RICH VALLEY, SMYTH COUNTY, VIRGINIA

Edward L. Lee; *Virginia Polytechnic Institute*

11. The Effna limestone, which immediately underlies the Middle Ordovician black graptolitic shales in a portion of Rich Valley southwest of Porterfield Quarry and Worthy Mine, is a high-calcium limestone that varies considerably in thickness. The maximum thickness is about 175 feet and the formation thins to the southwest and finally pinches out entirely. The limestone is a typical calcarenite and constitutes a great bank of shell sand conaining little magnesium carbonate and relatively little insolubles. The thickness of the limestone and chemical analyses obtained from channel samples taken from excellent outcrops provide a

basis for estimating the limestone reserves in a belt about 4 miles long. Locally the stone is sufficiently thick and pure to be minable just as it is at Portefield Quarry and Worthy Mine, operated by Olin Mathieson Chemical Corp.

STRATIGRAPHY AND BRACHIOPOD FAUNA OF THE CHATHAM HILL LIMESTONE AT THE TYPE LOCALITY

Donald E. Hallinger; *Virginia Polytechnic Institute*

12. The lithology and fauna of the Chatham Hill limestone have never been completely described at the type locality in Smyth County, Virginia. Two detailed stratigrahic sections in the Chatham hill limestone were measured, one at the type locality 3.0 miles south of Chatham Hill, and the second approximately 5 miles north along strike at a point 2.5 miles southwest of Nebo, Virginia. Many well preserved brachiopods were obtained by dissolving limestone samples from a number of zones in the Chatham Hill limestone. Among them are *Sowerbyella perplexa, Dinorthis transversa,* and *Opikina dorsatiformis* which were not previously reported at the type locality. In addition, large numbers of specimens were obtained which provide additional information on the morphology and stratigraphic and geographic range of species previously described by G. A. Cooper from nearby areas.

STRATIGRAPHY AND PLEONTOLOGY OF THE "MAYSVILLE" DIVISION OF THE MARTINSBURG SHALE FORMATION NEAR CHATHAM HILL, SMYTH COUNTY, VIRGINIA

R. L. Sutherland; *Virginia Polytechnic Institute*

13. The Maysville division of the Martinsburg, characterized by the well-known brachiopod, *Orthorhynchula stevensoni,* constitutes one of the best known stratigraphic zones in the Paleozoic succession of the Appalachian Valley region. The major purpose of the writer's study was to determine whether the various well-known fossils in the *Orthorhynchula* zone constitute one faunule or several definite faunules. The characteristic lithology of the zone is a calcareous siltstone, some layers of which are characteristically concretionary. This type of lithology is gradational with the cross-laminated sandstones of the overlying Juniata. The fossil pelecypods and inarticulate brachiopod, *Lingula nicklesi,* seem to occur together in many places. *Orthorhynchula* is common in various beds throughout the zone that bears its name. *Lingula nicklesi* is more characteristic of the upper part of the zone which averages about 85 feet thick, but it also occurs in the lower part of the division. The Maysville clams are very characteristic of a zone about 10 feet below the top of the Maysville division.

SECTION OF PSYCHOLOGY

CERTAIN TIME RELATIONS IN SERIAL ROTE LEARNING

Gene Wilson and Rosemary Hartman; *The College of William and Mary*

1. To determine why the serial position curve is skewed, Deese and Kresse employed 4-sec. and unpaced rate sof nonsense syllable presentation. The present study repeats these conditions and adds an 8-sec. rate. Both obtained typical serial position curves. Remote associations were symmetrically distributed about the center of the list. The curve of failures-to-respond in the Deese and Kresse study was skewed under the paced condition and reached an asymptote near the middle of the list fo rthe unpaced condition. The present study found bowed curves for all rates of presentation although this effect was least pronounced under the unpaced condition. Rate of presentation appeared to have had its greatest effect on failures-to-respond.

INDIVIDUAL DIFFERENCES IN BINARY PATTERN RECOGNITION

Dorothy W. Dyer and E. Rae Harcum; *The College of William and Mary*

2. Right-left field differences in accuracy of reproducing tachistoscopically exposed binary patterns were investigated. Observer's eye dominance and cerebral hemisphere dominance were simulated, respectively, by monocular viewing and by different element contrasts in opposite hemi-fields. Relatively greater accuracy occurred for elements having greater contrast. Group results indicated greater accuracy left of fixation, and no effect of viewing eye. However, of the twelve observers the four who exhibited nearly equal binocular performance for the two hemi-fields also exhibited superiority of the nasal retinae with monocular viewing. A learned bias favoring left elements apparently can overcome viewing eye effects.

ATTENSITY GRADIENTS IN THE PERCEPTION OF BINARY PATTERNS

David Camp; *The College of William and Mary*

3. Three experiments were performed investigating binocular perception of ten-element binary patterns tachistoscopically exposed to the right or left of fixation. Experiment I, using blackened and open circular elements, yielded minimal errors of reproduction adjacent to fixation, maximal errors at the sixth position, and a relative minimum at the extremes. There were no right-left differences. In Experiments II and III an attempt was made to flatten the error curves by adjusting target

size and brightness respectively as a direct function of the errors made in Experiment I. In both cases there was an increase in errors in the foveal region with no significant peripheral effect.

A FURTHER EXPERIMENT CONCERNING DEPENDENCY CONTRAST IN VISUAL DEFECTION AND RECOGNITION

E. Rae Harcum; *The College of William and Mary*

4. The surface microstructures in eight target forms were the same as or different from background surfaces. For a given surface, a unit of microstructure was black or white depending upon whether it was different from the brightness of the adjacent preceding unit in an arbitrary sequence. Dependencies of 100%, 75%, and 50% produced three different surfaces. Generally, a greater difference between target-surface microstructure and background microstructure produces more frequent target detections. Stimulus characteristics determining recognition of target form are also discussed. The results from these 26 observers corroborate those reported earlier for two observers tested under somewhat different conditions.

THE ACQUISITION OF PROBABILISTIC PAIRED ASSOCIATES AS A FUNCTION $S\text{-}R_1$: $S\text{-}R_2$ RATIO AND BLANK TRIALS

James H. Woods; *University of Virginia*

5. Previous studies of probabilistic paired associates, in which two response syllables are learned to each stimulus syllable, have shown that response frequency is an increasing function of stimulus probability. This study compared the influence of increasing numbers of blank trials (trials on which neither response member occurred) within the above framework. The results indicated that frequency of response for the more frequently occurring response syllable decreased as blank trials increased. However, the less freqeunt response was not affectd by different numbers of blank trials.

SOME EFFECTS OF LONG-CONTINUED, LOW-INTENSITY, GAMMA IRRADIATION ON THE RAT

Leonard E. Jarrard; *Washington and Lee University*

6. Rats were continuously exposed for 60 days to a low-intensity source of cobalt 60. One group of 24 animals received 539 r., another group received 230 r., and an additional 24 served as nonirradiation controls. Body weight and food consumption were recorded throughout the irradiation period. Half of the animals began training in a water

maze after 7 days while the other half started training 37 days after irradiation. Results indicated that for these conditions, a small amount of continuous irradiation affected body weight but not learning, whereas a greater amount was accompanied by a decrement in learning but no further loss in body weight.

AN EXPERIMENTAL INVESTIGATION OF FORGETTING AND ANXIETY

John H. Borghi; *The College of William and Mary*

7. A repression-like inhibition was observed for associate responses when followed by a raucous buzzer. Subjects were asked to respond to one-hundred Kent-Rosanoff words and were buzzed when they gave certain critical responses. The initial instructions suggested to the subject that these buzzed responses were "poor." Following the administration of a Taylor Anxeity Scale, the subjects were asked to recall all one-hundred responses. There was less recall of the buzzed words, indicating some support for the hypothesis of repression.

CONDITIONS DETERMINING SHORT-TERM RETENTION IN SEQUENTIAL TASKS

H. R. Brackett; *University of Virginia*

8. Three experimental conditions were employed to test the effect of interference when the members of natural classes of items do not occur togther but are mixed among different arbitrary categories which shift in their makeup from presentation to presentation. Condition I afforded opportunity for grouping but offered a minimum of inter-items interference. Condition II prevented grouping and provided opportunity for interference. Condition III prevented grouping but minimized interference. It was predicted that recall scores would be best under Condition I, next best under Condition II, and worst under Condition III. These hypotheses were borne out by the results of the experiment.

WORK AS A MEASURE OF MOTIVTION IN OPERANT CONDITIONING

Nelson F. Smith; *The College of William and Mary*

9. A progressively increasing work load was required of animals under different periods of food deprivation. White rats pressed a lever in a Skinner box to operate a mechanical food vender. Rats were tested under four periods of deprivation; 0, 24, 48, 72 hours. The work load was varied by progressively increasing the weight on the lever. It is thought that the maximum load undertaken by the rat might be used as a measure of the motivation induced by food deprivation, since the data thus far indicate a linear relationship between work load and hours of deprivation.

A Bar Press Apparatus Suitable for Construction and Use by Students

Peter Guthrie and David Camp; *The College of William and Mary*

10. An undergraduae laboratory for studying animal behavior was provided with bar pressing apparatus by having the members of the class construct their own equipment from pre-cut aluminum sheets, bars and angles. The class, working in pairs, constructed this equipment during the first two three-hour lab periods of the semester at a cost of about $3.50 per box. This apparatus has proved reliable in the demonstration of magazine training, operant conditioning, extinction, spontaneous recovery, discrimination learning and the effects of several schedules of reinforcement. The project appears to have had heuristic value for the students involved.

Distribution of Practice in Concept Formation

James Crouse; *College of William and Mary*

11. Does massed practice facilitate the learning of concepts? Some evidence in the literature suggests that it may if certain conditions are met, in spite of the well-known principle that it hinders rote learning. This experiment required Ss to discover a concept, i.e., the consonants k, p, r, t, embedded in some of the groups of a list of 180 pairs of groups of eight consonants presented by a modified memory drum. Two groups of 24 college students practiced without a rest or with 45 seconds rest after every ten stimulus presentations, with an eight-second inter-stimulus interval held constant. The results indicated that learning was significantly faster by massed practice.

The Secondary Reinforcing Value of Low Intensity Shock

Douglas K. Candland and James F. Campbell; *University of Virginia*

12. Research based on reinforcement theory has tended to separate stimuli into categories, such as positive and negative, or appetitive and aversive. Such distinctions have obscured the possibility that a stimulus may assume different properties depending upon its effect on the organism during previous training. To test the possibility that a negative stimulus could become positive, this study used electric shock in a bar-press situation to determine whether the shock would assume positive properties as a secondary reinforcer. Rats were trained to press for food reinforcement with a constant current a.c. shock accompanying each bar-press. All rats were then extinguished, so that food no longer accompanied a bar press. Half of the animals received shock with each bar press, while the other half did not receive shock. Both

groups responded the same number of times during a two-hour extinction period. The group which still received shock during extinction pressed at a slower, but more consistent, rate than did the group for which shock was eliminated during extinction. It was concluded that shock may come to serve as a positive reinforcer with training.

THE EVOKED ELECTROCORTICAL RESPONSE AND ITS RELATION TO BEHAVIORAL CONDITIONING

George M. Gerken; *University of Virginia* and
William D. Neff; *University of Chicago*

13. Bipolar electrodes were implanted in auditory cortex of six cats. After the cats recovered from surgery, the potentials evoked from auditory cortex by acoustic stimuli were recorded with an EEG machine over a period of 18 to 21 daily sesisons. During these sessions, the animals were restrained in a conditioning apparatus that permitted leg flexion responses. All animals received either six or nine preconditioning sessions which were followed by sessions in which classical conditioning, avoidance conditioning, and pseudo-conditioning training procedures were used. A session by session analysis of the EEG records showed that a variety of changes took place in the evoked potential during the preconditioning period and during conditioning. These changes did not present a consistent pattern from cat to cat.

INTERACTION OF HUNGER AND ESTRUS IN THE RAT

Robert L. Rhyne; *University of Virginia*

14. Twenty-two hour food deprivation in the mature female rat produced relatively greater changes in wheel activity during the anestrum than during estrus. The character of running behavior was differentially altered depending on whether the animal was restricted or free to run during the daily feeding. Concurrent measures of food consumption, water intake, and body weight showed no consistent relationships to either amount of activity or to the hormonal state as determined by daily vaginal smears. Recovery periods showed essentially normal running patterns with a reinstatement of inverse relationships between ingestional and body weight changes, and the estrous activity cycle.

DISCRIMINATION REACTION TIME TO A VIBROTACTILE DISPLAY

Raymond C. Bice, Jr.; *University of Virginia*

15. As a part of a program studying the problems associated with tracking to vibratory stimulus displays, a vibratory discrimination reaction time test has been devised. The directional stimuli are presented

by four skin vibrators mounted in a rubberized vest in such a way that the stimuli are delivered to the chest. Subjects learn to react correctly and rapidly to the display, but there is greater difficulty when the response panel is horizontal (at right angles to the display) than when it is vertcial (parallel to the display) because of disturbances in the body image. Subjects tend to regard stimuli delivered to the upper part of the chest as nearer than those delivered low on the chest.

ELECTRICAL STIMULATION OF THE SKIN — ON PURPOSE

Robert H. Gibson; *University of Virginia*

16. Pain is readily produced by electric stimuli. This is fortunate for research on pain, but limits the usefulness of electric signals for tactual communication. The present report is part of an investigation to find conditions for painless electric stimulation. Previous findings were that painless stimulation with alternating current was possible on only certain areas of the body, other areas responding with pain. It is now found that the latter areas will also yield painless sensations when stimulated by certain temporal arrangements of brief, biphasic electrical pulses.

THE SCALING OF MOTOR NOISES IN TERMS OF ANNOYANCE

James Harvey Brown; *University of Virginia*

17. Ten motor noises were recorded on tape and equated for loudness. Groups of subjects scaled these noises in terms of annoyance by the method of successive intervals and the method of paired comparisons. Spectrograms were made of each noise. Within and between scale analyses were made in terms of position on the scale, significant differences between the scale values, and the spectrograms. Six of the original ten noises formed a final scale, the utility of which lies in its potential use for determining the annoyance values of other motor noises.

THE DEVELOPMENT OF AFFECTIONAL RESPONSES IN INFANT DOGS

George J. Igel; *University of Virginia* and Allen D. Calvin; *Hollins College*

18. Dr. Harry Harlow has shown that, for monkeys, "contact comfort" is a more important variable than lactation in the development of the affectional bond between infant and mother. The preesnt study was undertaken to (1) investigate the development of the affectional bond in a species other than the monkey, namely the dog, and (2) to investigate further the effect of lactation on the development of the affectional responses. Sixteen mongrel puppies served as subjects. The results of the present study show that dogs also prefer cloth mother to wire mothers under all conditions of feeding, but that lactation is a

variable of significant importance when paired with cloth mothers, but that lactation is not a significant variable when paired with the wire mothers.

TESTING IN JUVENILE COURT: (SURVEY

Ray Naar; *Richmond, Virginia*

19 The importance of environmental factors upon a Subject's performance has often been recognized. It was felt that the performance of juvenile delinquents would be particularly affected by the fact that these children had come within the purview of the law. To determine whether this belief was shared by other psychologists working under similar circumstances, as well as what steps were taken to neutralize or account for such factors, a questionnaire was mailed to a number of juvenile courts throughout the country. The answers to the questionnaire were tabulated and discussed.

NEED AFFILIATION: APPROACH AND AVOIDANT ASPECTS

Richard N. Carrera; *V.A. Hospital, Richmond, Virginia*

20. The French "Test of Insight" was employed to investigate the correlates of need affiliation, which may be defined as a need to be with and be liked by other people. Findings indicate that there are two general types of need affiliation, which may be designated positive and negative on the basis of underlying motivation. Positive need affiliation is a genuine liking for other people, which results from a history of satisfying relaionships with others. It is positively correlated with personal popularity and may be regarded as a personality asset. Negative need affiliation is defensive in quality and is based on a chronic fear of rejection. This trait tends to be negatively correlated with effectiveness in interpersonal functioning.

MENTAL HOSPITAL ADMISSION RATES AS A MEASURE OF THE EXTENT OF MENTAL ILLNESS IN MODERN AMERICAN SOCIETY

Henry B. Adams; *V.A. Hospital, Richmond*

21. Admissions to mental hospitals have multiplied in recent decades. Is there an increase of incidence of mental illness in modern society? Analysis of hospital admission figures raises doubts about such an interpretation. Rates of admission vary widely from state to state. Almost all this variation can be explained by (1) the number of hospital beds available and (2) the rate at which deaths and discharges make space for new admissions. Differences in urbanization, income, and proportions of the aged in the population have only limited effects on admis-

sion rates. These rates are often influenced by many factors unrelated to the incidence of mental illness, and there is no conclusive evidence that any true increase has taken place.

INTELLIGENCE AND LOGICAL REASONING ABILITY

Fred McCoy; *University of Richmond*

23. Whether logical reasoning ability may be considered primarily learned or innate has shown conflictin gevidence. Present work shows a close relationship between intelligence and logical reasoning ability.

TWO VALIDITY STUDIES OF THE WIDE RANGE ACHIEVEMENT READING TEST

Rudolph F. Wagner and Fred McCoy; *Richmond Public Schools*

24. The Wide Range Achievement Test, reading section, is appealing in its simplicity and interview-type administration, but is generally rejected by experts because it is unorthodox and unsupported by research. In independent studies, Wagner and the Clinic staff found the WRAT to correlate beyond the .01 level with several validation criteria, and when the two studies were compared, to have striking similarity in results. Results of the two studies tend to support the validity of the test.

SECTION OF STATISTICS

COMPOUND BINOMIAL DISTRIBUTIONS AND TARGET THEORY

Malcolm E. Turner; *Medical College of Virginia*

1. The probabilistic theory of hits by quantum particles upon microscopic targets has had wide application in biological research. These applications include problems in the inactivation of viruses by radiation and discernment of the number of quanta required to produce a visual image. The theory as developed by Timofeev-Ressouvsky and Zimmer is reviewed and certain extensions, variations, and modifications are suggested in light of certain compound distributions of the unknown parameters.

SEQUENTIAL ALLOCATION OF PATIENTS IN CLINICAL TRIALS

Robert J. Taylor; *Virginia Polytechnic Institute*

2. A scheme for conducting clinical trials that allows the proportion of patients assigned to the various treatments to be changed at specified imes during the course of the trial depending on the results up to that

time is discussed. The proportion of patients assigned at each stage is determined by use of a "weighting function." Several weighting functions are presented along with the results of sampling experiments using random numbers to simulate actual clinical trials. These results are compared to the situation with equal proportions of patients on all treatments discussed by Sobel and Huyett.

On the Combination of Errors in Agricultural Research

N. R. Thompson; *Virginia Polytechnic Institute*

3. Some agricultural investigations involve one or more stages of sampling, followed by chemical analyses and experimental trials. Also, certain biological "constants," derived from previous obseravtions, may enter into the calculations. The results from such investigations, if used to make inferences applicable to whole populations, should be evaluated with respect to all sources of error. Linear combinations of the individual errors may be appropriate. Some errors may be much larger, and therefore of more importance, than others. Also, when variances of the "constants" are included, the total error may increase.

The Measurement of Risk in Agricultural Production

Paul H. Hoepner; *Department of Agricultural Economics, V.P.I.*

4. This discusison deals with the statistical techniques used to measure the risk involved in certain phases of agricultural production. The primary tool used was the two-way analysis of variance model with the data classified by years and farmers. After certain necessary adjustments in the data, variance components are computed from the mean square terms to estimate the variance associated with years, farmers and random error. Both year and random error variances constitute risk. Finally, the discussion deals with the estimation of the variance of a sum, difference, product and quotient, to indicate the procedures used to combine the numerous variance estimates into a single measure of risk (variance of net income).

The Reliability and Cost Considerations of Systems with Spare Components

Donald F. Morrison; *National Institute of Mental Health* and *Virginia Polytechnic Institute*

5. A *system* is said to consist of n components, not necessarily of the same kind, whose lives are independent random variables specified by some known probability distribution. Failure of any component will cause the entire system to fail. In addition to the original components,

a set of k spare elements is available for replacing successive failures within the system, until the $(k+1)$th failure, when the system ceases operation. The distribution of system life has been determined for a general component life density $f(x)$, and expected total life has been evaluated for certain gamma-type densities. System *reliability*, or the probability that the final failure will not occur prior to some time T, has been tabled for certain of these densities. Since total life is not the only measure of the advantage of including spare components with a system, the distribution of the number of element failures on a given time interval has been investigated. From the expected numbr of failures on the interval, expected total life, and system reliability, a cost function for determining the optimum number of spares is proposed. Systems with different types of components present a more complex statistical problem. Such devices have been studied for exponential component lives with a different failure rate for each type. Expressions for expected system life have been obtained, and tables for allocating spares to different component groups for maximum expected system life or reliability have been constructed.

SOME TESTS FOR OUTLIERS

C. P. Quesenberry and H. A. David; *Virginia Polytechnic Institute*

6. This paper will propose a test statistic which is the extreme deviate from the sample mean divided by a pooled estimate of the standard deviation. The components of the pooled estimate consist of the estimate from the sample and an independent estimate. This statistic is appropriate for a one-sided test. The modulus of the above statistic is proposed for the two-sided test. Some tables of percentage points will be given for both of these statistics for the 1 and 5 per cent levels.

A SOYBEAN EXPERIMENT INTERPRETED WITH RESPECT TO GENETIC MODELS

Theodore W. Horner, Booz, Allen Applied Research, Inc., and Charles R. Weber; *Iowa State University*

7. Estimates of genotype components and environmental variances were obtained as functions of thirty covariances and variances computed on data involving the F2 through F7 generations of a soybean cross. The estimated genotype and environmental variances were then used to estimate gains from selection. These were then compared to observed gains from selection and found to agree closely with respect to some characters and poorly with respect to others.

A STUDY OF SOLDIER PREFERENCES FOR VARIOUS BLENDS OF ROASTED AND GROUND COFFEES IN THREE STRENGTHS

Elie Weeks; *Quartermaster Research and Engineering, Fort Lee, Virginia*

8. During the fall of 1959 the Food and Containers Engineering Branch, Quartermaster Research and Engineering Field Evaluation Agency conducted a test of four blends of roasted and ground coffee and one type of instant coffee. Each blend or type was prepared and served in three strengths to some 720 soldiers stationed at Fort Lee, Virginia. Each soldier tasted and rated four coffees. The design of test was a partially balanced incomplete block design, in which each of the 15 "coffees" was served to an equal number of men in each of the four serving orders at each of the eight test sessions. This design provided 960 ratings for each of the three coffee strength levels, and 576 ratings of each of the five blends or types of coffee. Ratings were obtained on a 9-point hedonic scale ranging from "Like Extremely" to "Dislike Extremely."

CONTRIBUTIONS TO THE METHOD OF PAIRED COMPARISONS

H. A. David; *Virginia Polytechnic Institute*

9. The method of paired comparisons is widely used in sensory difference testing whenever judgments have to be of a subjective nature. It has been applied to taste testing, color comparisons, personnel rating, and generally to all forms of preference testing. In the present paper a new approach both to the execution and the analysis of paired-comparison experiments is discussed. This approach is based on the analogy between these experiments and popular methods of organizing competitions, such as Round Robin and Knock-out tournaments.

SOME ASYMPTOTIC RESULTS IN A BALANCED PAIRED-COMPARISON EXPERIMENT

B. J. Trawinski; *Virginia Polytechnic Institute*

10. In a balanced paired comparison experiment involving t treatments, $T_1, T_2, \ldots T_t$, subject to sensory judgment, each treatment is compared with all the remaining treatments once in every replication. The number of replications n is determined in such a way that the best treatment is declared as such with a preassigned probability P. It is assumed that there is no difference between the judges or the n replications. The assumption in the model is that the best treatment is better than the second best by a specified probabiliy of preference

$$\pi = \tfrac{1}{2} + \Delta, \quad 0 < \Delta < \tfrac{1}{2},$$

and the probability of preference for any comparison between the treatments excluding the best is $\pi = 1/2$; this situation is usually referred

to as the least favorable configuration. With the above model and asymptotic distribution theory a table has been prepared giving the number of replications necessary for the detection of the best treatment with specified probability P. The entries n are functions of π, t, and P.

METEOROLOGICAL APPLICATIONS OF POWER-SPECTRUM ANALYSIS

R. E. Walpole; *Roanoke College*

11. The applications of power-spectrum analysis to meteorological data are discussed in general and then illustrated specifically by obtaining a power-spectrum analysis of horizontal wind speed on data collected from a 200 foot steel tower at the White Sands Missile Range. The results are compared with similar analysis made at Brookhaven National Laboratory and Oak Ridge. The data was collected in a dry desert-type climate from a flat countryside bordered by two mountain ranges approximately one hundred miles apart. The method of analysis is given and the results are discussed. The direction for further investigation is suggested along with the difficulties that arise.

MULTIVARIATE ANALYSIS OF INCOMPLETE-VARIABLES DESIGNS

Irene Monahan; *Virginia Polytechnic Institute*

12. Methods of estimation and tests of hypotheses are developed for multivariate experiments in which a different subset of the p variables under study is observed in each of k groups of n sampling units. The matrix of observations in the i th group is $Y_i' = X_i'M_i$ where M_i is a matrix of ones and zeros which selects from X_i' (n x p) the u variables measured. An explicit expression for the maximu mlikelihood estimate of the parameter matrix and an equation involving that of the dispersion matrix are obtained by differentiating the likelihood function for the whole sample of kn observations. The latter equation is solved by the Newton iterative method.

SOME CONTRIBUTIONS TO THE EVALUATION OF PEARSONIAN DISTRIBUTION FUNCTIONS

John White; *Virginia Polytechnic Institute*

13. This paper represents a report of the construction of extended tables of percentage points of the Pearson Distributions. It consists of two parts: (1) The evaluation of the cumulative distribution function of the Pearson system (except for the so-called Type IV distribution) for a given pair of parameters β_1 and β_2; and (2) The determination of percentage points associated with a given probability level. The tables

presented here have been extended, both in accuracy and as well as increasing the ranges of β_1 and β_2. Numerical illustrations are presented showing the closenes of the Pearson approximation with the exact distribution.

THE PREDICTION OF COLLEGE SUCCESS FROM TESTS AND HIGH SCHOOL ACHIEVEMENT

John M. Long; *The College of William and Mary in Norfolk*

14. The predictive data used were scores on entrance tests and high school records for a group of freshmen at the College of William and Mary in Norfolk. The criterion of the study was College quality point average. Standard multiple regression analysis techniques were used. Considered in this paper are: (1) High school quality point average was used. Eleven other academic ability and achievement measures were used. Ten personality scales and ten interest indices were also used. (2) Thirty-two predictor variables were used. The inter-dependence of most of the variables resulted in a spreading out effect which obscured many otherwise significant variables. Smaller groups of one, two and five were selected. The results compared favorably with that for all thirty-two variables. (3) Computations were performed on an I.B.M. 650 Data Processing System. The smaller groups were selected using the Wherry-Doolittle Test Selection Method and using variables with highest simple correlations with the criterion. Certain implications for prediction of a complex criterion are discussed. For such studies the size of the sample needs to be quite large. The value of using such a large number of interdependent variables is doubtful.

OPTIMUM ALLOCATION IN REGRESSION SPLIT-PLOT EXPERIMENTS

R. M. DeBaun; *American Cyanamid Company* and
Victor Chew; *U. S. Naval Weapons Laboratory*

15. In the literature, experimental designs for regression analysis are usually optimized with respect to the total number of observations to be taken; also, in the optimization, the cost of taking an observation is assumed to be the same for all treatment combinations. In this paper, cost functions are introduced and optimum designs are derived for both extrapolation and interpolation, including split-plot situations where the cost of taking an additional sub-plot observation is small relative to that of a main plot.

CONDITIONAL DISTRIBUTIONS ARISING FROM VARIATION OF PARAMETERS IN A NON-LINEAR RESPONSE FUNCTION

Max H. Myers and David C. Hurst; *Virginia Polytechnic Institute*

16. This paper proposes that the growth of an individual organism follows a mathematical model closely and that different individuals follow different members of the same parametric family of models. This implies that the variation observed between individuals measured at the same time arises not from an additive term as has been previously supposed, but primarily from variation of the parameters of the model. A graph of data from an experiment on chickens is included which points up this individuality and the increased variation resulting from the passage of time. The three models considered were growth curves employing two, three, and four parameters, respectively, with biological interpretations existing for the parameters. The parameters were allowed to follow independent uniform distributions and independent gamma distributions.

GROUP TESTING IN BINOMIAL AND MULTINOMIAL SITUATIONS

Rolf E. Bargmann and Frederick L. Carter; *Virginia Polytechnic Institute*

17. This is a study and extension of methods of finding defective members in a population by testing groups of an optimum size. For the case where the over-all population size is finite, strategies by Sobel and Groll, and Sterrett were discussed. Properties and extensions of the Dorfman technique were considered. This is the situation where the population may be infinite or unspecified. A somewhat related problem concerns the detection of error in iterative procedures, where cumbersome checks have to be made at certain intervals.

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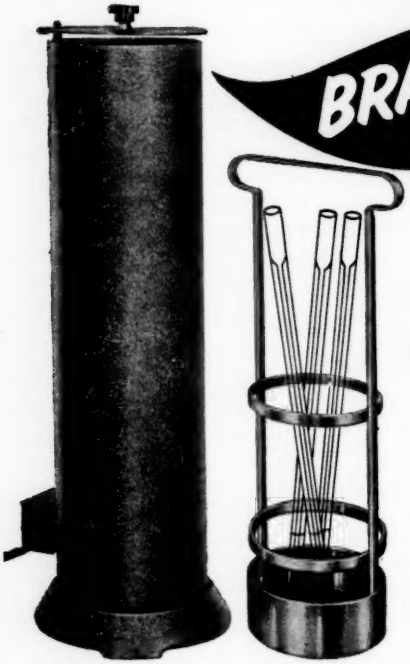

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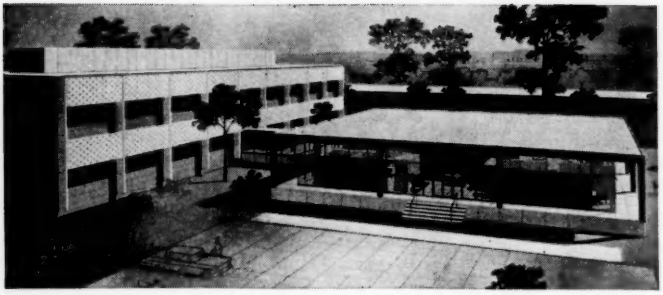

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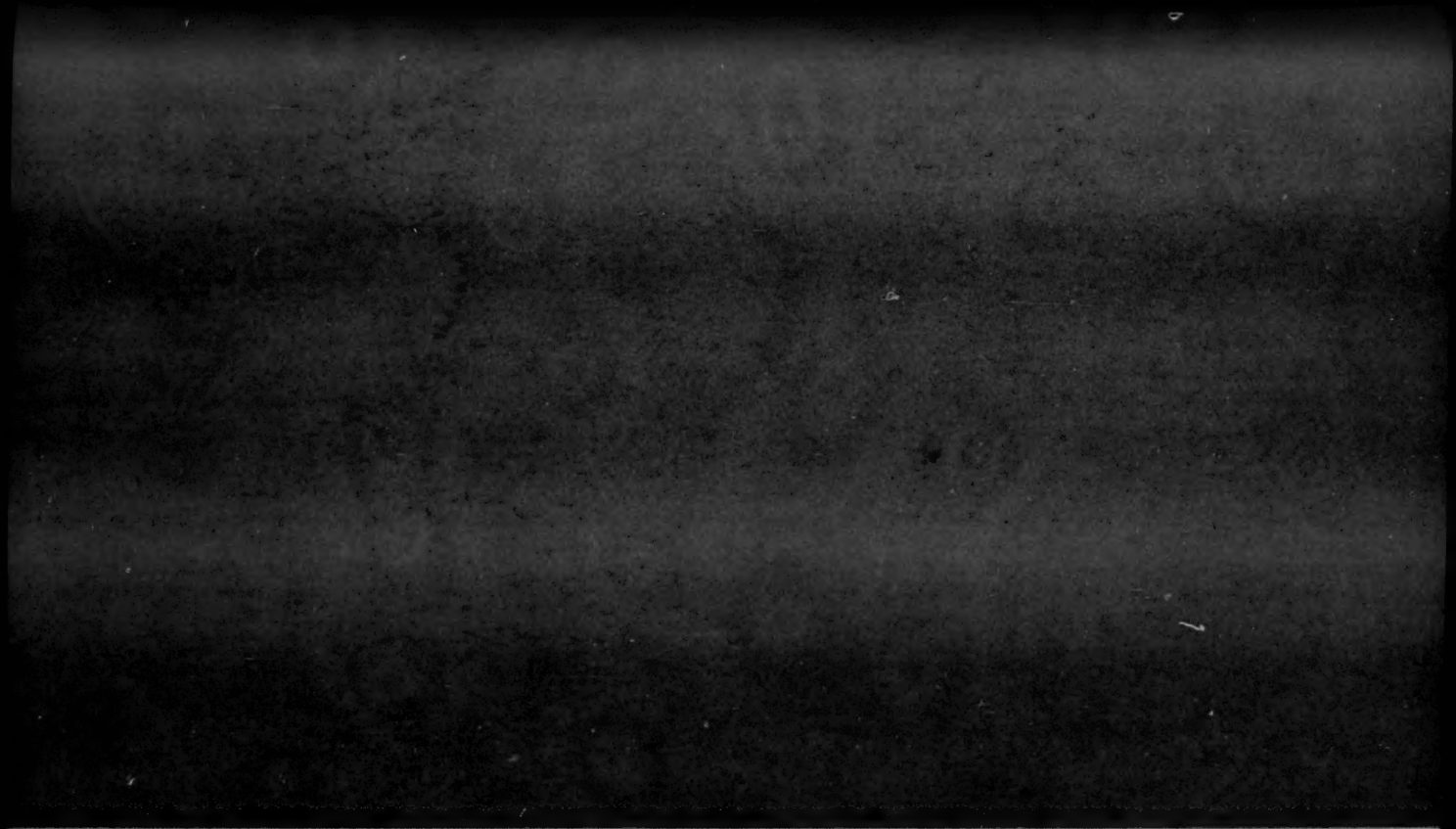
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